

A Semimonthly Technical Newspaper

Metallurgical & Chemical Engineering

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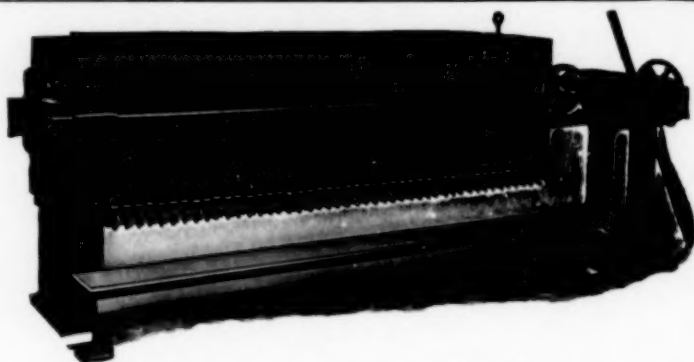
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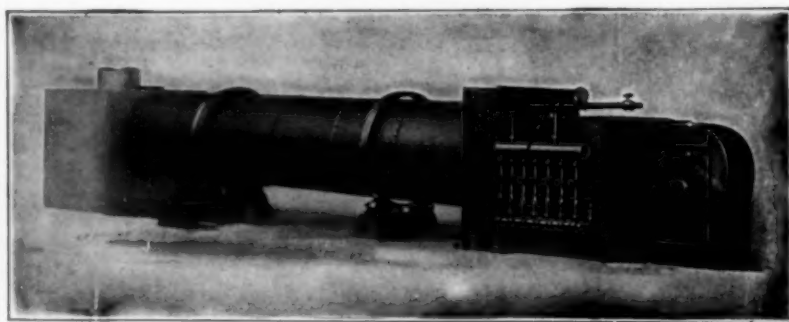
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Potash, I. W. W., and the Fuel Administration

The sand hills of Nebraska are capable of supplying our most urgent needs for potash. Energetic Nebraskans have supplied the capital and plants and are now ready to turn out the salt. But these potentialities bid fair to be wasted through the attentions of traitorous I. W. W. and a corresponding inattention of various branches of officialdom.

Near Alliance, four evaporating plants aggregating over 5000 boiler horse power are evaporating nearly 10,000,000 lb. of brackish lake water daily, producing every 24 hours something like 350 tons of salts containing approximately 25 per cent of water-soluble potassium oxide. This production figures up to the rate of 32,000 tons of K_2O per annum. But even this most credible showing is a long way from the needs of the United States, which amounts to about 275,000 tons.

The speed and energy with which this production has been developed may be appreciated when it is known that the present output is approximately ten times the production of this district for the year 1916, and over thirty times the production of the entire United States during 1915. One plant, whose present output of potash is nearly one-fifth that of the region, started construction on Aug. 15, 1916, and shipped three carloads the latter part of November—100 days later.

Not only energy and resourcefulness on the part of the engineers has been required, but a great amount of courage has been evidenced by the capital invested. The production of potash from these fields would have been precarious before the war, and, for that matter, will be after the war if the American companies feel the effect of an unrestricted German trade-war. This may easily be demonstrated by the following approximation of the present cost of a ton of K_2O as produced in Nebraska.

4½ tons of coal at \$3.00 per ton....	\$13.50
200 gal. of fuel oil at 8c. per gallon..	16.00
22 hours' labor at 30c. per hour.....	6.60
Material for repairs and renewals...	4.00

Total cost at Alliance, Neb.....\$40.10 per ton K_2O
This allows nothing for interest, amortization or profit, nor for royalties, which latter may amount to 20 per cent. Compare the probable cost of this potash to the American user with the cost of German material, remembering that the Schmidtman mines have contracted for 50 per cent K_2O muriate at \$15.00 per ton and Kainite (12 per cent K_2O) at \$2.00 per ton, even though the price of the former product was about \$32.75, f.o.b. American ports during 1912 to 1914.

The possibility of successfully meeting the cut-throat competition of the Huns rests mostly upon factors beyond the control of the operating companies. For instance, it would undoubtedly be good practice to fire powdered coal exclusively, thus eliminating the costly though handy fuel oil. A plant thus operated should have been able to produce potash six months ago at an operating cost less than half that estimated above. But the incentive to such improvements is now largely lost since the fuel administration forced the potash producers to give up their contracts with coal companies for ample fuel at 40 cents a ton (and which the coal companies were apparently glad to sign) and substitute therefor fluctuating supplies of the same commodity at a two-dollar advance.

Again, such improvements are almost out of the question on account of the execrable deliveries on materials now ruling. At the present time there is at least 3500 additional horsepower in plant capacity under construction or contract, which should increase the total production of this district about 80 per cent. Yet the deliveries on this material are so slow that no large increase in Nebraska is expected before the summer of 1918.

During a visit of inspection early in November, the largest plant was found completely shut down on account of "no coal," while the next largest producer was practically idle in an effort to eliminate American traitors from his organization. Nearly 70 per cent of the total output was thus suspended.

To produce potash, the Nebraska operators absolutely need three things: first, plant protection; second, ample coal, and third, adequate fuel-oil.

In the first case the I. W. W. have descended upon these mushroom communities—evidently they are better informed as to these strategic points for operation than the governmental agencies who should be rounding them up for summary war-time justice. Second, the coal situation is aggravating in the extreme—only another instance of how exorbitant prices fail to stimulate supplies. Third, the Standard Oil Company has just notified the potash producers that they would be unable to ship further supplies of fuel-oil.

Leaving the labor situation aside for the moment, urgent as it is, it does seem that the other factors should receive attention from some national authority. For the production of potash is unquestionably a national necessity. Among the multitude of committees, subcommittees and boards now operating at Washington, there should be some committee on chemicals which recognizes the urgency of this matter, and with authority to bring the fuel administration, transportation board and priorities committee to the place where they will arrange for a continuous and ample supply of fuel to this industry. The price is not in question—but a sufficient supply is absolutely essential.

A School of Mines Debauched

Colorado is being treated to an experience the like of which seldom if ever has been forced upon a sovereign State. She has been compelled to sit aside and

watch the slow but certain disintegration of her School of Mines, due to the ignorance and unfitness of a majority of the school's trustees who are charged with its welfare. This is a matter of more than local concern, for the institution has had an honorable career, and its graduates have played an important part in the mining industry of the United States and foreign countries. For them the recent fiasco at their *alma mater* is a source of the deepest regret.

Beginning last spring, when the trustees refused to support the president and faculty in the discipline of students guilty of drunkenness, rowdiness, and assault on an instructor, there has been a succession of incidents calculated to undermine efficiency and impair the reputation of the school. At that time honor was subordinated to the dollar mark, and principle was abandoned for expediency. Trustees ignorant of their official function, and wholly lacking in appreciation of the ethics of the situation, forced their personal wishes in spite of public and private protest. The president was dismissed, the faculty humiliated, and the students' outrageous conduct upheld.

Confronted then with the problem of finding a new head for the school, the trustees early discovered that no self-respecting and able educator and engineer would accept the position. The opening day of the present session was rapidly approaching, with no willing candidate in sight, when finally, in sheer desperation at their inability to induce a competent man to take the place, the majority of the board committed the astounding blunder of offering it to a former incumbent who had been removed four years previously after charges of a disreputable nature had been made and substantiated. Despite the renewal and proof of charges of unfitness, and against the protests of alumni and friends of the school, the infamous deal was consummated, to the discredit of the State and one of its institutions.

The opposition to this action on the part of an unfit majority of the board was vigorous and determined. Alumni sought to prevent the debauchery of their *alma mater* by instituting suits to restrain the trustees and oust the president. Thus the matter dragged its slimy length through the courts and paraded its shady details in the local press, to the discredit of the institution and its responsible officials. The end is not yet, though it is doubtful if further attempts will be successful in changing the situation. The net result is that Golden stands discredited, with a president in disrepute, and a board of trustees the majority of whom are held in utter contempt.

The trouble in Colorado is fundamental, and the solution of the problem must be found beneath the surface of the teapot tempest in which the school's affairs have been embroiled. The management of the institution is vested by statute in a board of five trustees appointed by the Governor of the State. This is the beginning of the trouble, for executives have not exercised care to appoint men of large mental caliber. There has been too much yielding to political pressure and silly sentiment. In times past, political parties have sought preferment in the appointment of school

employees, and trustees have perverted their official positions to the attainment of personal ends.

A solution lies in complete reorganization by appropriate legislative action. The logical step is to abolish the board of trustees, combine the school with the State University, and administer its affairs through the regents and faculty of the latter institution. If this is not sufficient, let the school be removed bodily to the university, and thus avoid the pernicious meddling by small-town cliques. There would be economy of dollars and effort in such a consolidation, and a breaking away from some of the evil traditions that have grown strong in recent years. Such a move would be distasteful to older alumni, who dislike to see anything done to destroy the identity of the Colorado School of Mines, but even they probably would concede the wisdom of making some change to wipe out effectually and forever the present undesirable conditions.

A Controlled Iron and Steel Market

The iron and steel market is now under practically complete control of the Government. An initial batch of prices, to serve as a basis for the whole price structure, was announced at Washington Sept. 24. A second batch was announced Oct. 11 and a third batch, practically completing the price-fixing program, was announced Nov. 5.

The control of prices, except in the case of coke, which is fixed by the President by authority of the Lever act, occurs through agreement between the War Industries Board and the leading producers, the price announcements being made by the President upon recommendation of the board. To an extent the agreed prices represent compromises, but in general the compromises were effected by the War Industries Board bringing the manufacturers to its viewpoint, acquiescence in the specific prices being then readily granted.

Very fittingly, the details as to analyses, extras, differentials, etc., are left to committees of the American Iron and Steel Institute. The work can thus be done much better than by Washington agencies and there is the telling advantage that the regulations have a very friendly aspect. The industry is put upon honor and it is fully capable of carrying out the spirit of the arrangement.

Price setting, however, is but one feature of control. Through the priority authorities the sequence in which orders shall be filled is prescribed and thus complete control is assured.

The whole transformation has occurred with a smoothness and quickness that many did not anticipate, and yet it is all very simple. The Washington authorities required certain things, for the best conduct of the war, and did not insist upon more than was necessary. The full co-operation of the iron and steel trade was counted upon to supply the details and make the operation easy. That hearty co-operation is usually ascribed to what is known as the virtue of patriotism. It is very difficult, however, to assume

"patriotism" as a dissociated virtue, and analyze it. It is really largely an outgrowth of intelligence, vision and unselfishness.

At this crisis in the world's affairs an American who has vision and intelligence cannot possibly be selfish. If the iron and steel producers exhibit at this time what is called patriotism it is simply that they have intelligence and vision. They deserve no particular credit for having these qualities at this time, because that is a matter that was settled by other circumstances. The nature of the industry is such that only men of intelligence and vision remain in it. Others stay out, or if they chance to get in are shortly eliminated through being unable to maintain the pace.

The price structure that has been built up in a period of a few weeks is, from present viewpoints at least, a harmonious and well-proportioned one. The relations between material in its successive stages from crude material to finished product seem to distribute profits with a fair degree of equity.

The iron and steel market existing just prior to the inception of price-fixing was a declining one. The top had been reached in June. The declines in the interim had been slight, but they were sufficient to show the trend quite clearly. Eventually much lower prices would have come to rule, through the play of open market forces, but the declines would have been irregular, and least in the commodities most needed by the Government. The Government, in any event, could not wait, time being a vital element in war.

The prices are on the "one price for all" principle enunciated so clearly by President Wilson in his appeal of July 12.

Although the "one price for all" doctrine seemed to be clearly enunciated by the President last July there has been some misunderstanding, now quite largely dispelled. There were some who appeared to conclude that one price for all meant all, passing down the line from the producer to the distributor. They said that was impractical. Of course it was, so impractical that no one should have supposed that was meant. What was meant was that there should be one price, applicable alike in sales to the Government, in sales to the Government's allies, and in sales to those to whom the producers sold. The merchant, the "jobber," would buy as formerly, and sell at a suitable advance. If a steel producer conducts a jobbing or "store" business, as some do, it is a separate enterprise. When the first steel prices were announced there were some buyers who complained that the mills were not carrying out their agreement "to sell," because they stated they could not make the deliveries desired. The essence of the agreement, however, was really that when the mills should sell they would sell at not above the prescribed prices.

It is of value to note how the criticism and misunderstandings of only a few weeks ago have disappeared. Difficulties that may develop in future may disappear in like manner. The control is in comparatively smooth operation already, despite the shortness of the time and the intricacies of the case.

Readers' Views and Comments

Saving Sulphur in Sulphite Mills

To the Editor of Metallurgical & Chemical Engineering

SIR:—In your issue of October 15th, page 457, second column, 4th paragraph, you credit me with the statement that the Canadian consumption of sulphur is 300 pounds per ton of sulphite pulp produced, whereas the American consumption is only 250. This statement is slightly incorrect. American mills to-day are using from 250 to 450 pounds of sulphur per ton of sulphite produced. In a few isolated instances the consumption is less than 250 pounds. Canadian practice is equally as good as that in the United States. The point I wished to make was that there was room for improvement in the sulphur burning practice of nearly all sulphite pulp mills, whether in Canada or in the United States, and that improved practice would result in a material saving of sulphur.

ALFRED W. G. WILSON.

Department of Mines,
Ottawa, Canada

Naphthalene

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SIR:—Trouble is sometimes caused in buying naphthalene, which is occasioned by the ignorance of the buyer. We have known cases where naphthalene flake and balls with a melting point of 79 deg. C. have been sold as moth preparations. This is wrong. Only flakes or balls having a melting point of 80 deg. C. should be used for this purpose, in other words, the flake and balls should not only be white when made, but should hold this color when exposed to the light and air.

We have also known of brokers and buyers who are not posted selling a low grade of flake to manufacturers for chlorinating, when a very high grade of flake must be used for such purposes. A 79 deg. C. melting point flake is very suitable for most dye stuffs, providing it contains no anthracene and does not contain any petroleum or other impurities foreign to a straight coal tar product. Providing it does contain such impurities, it would show up in the sulphonating or nitration and would be a serious objection for dyestuffs.

F. H. B.

The Western Metallurgical Field

United States Production of Spelter

Figures compiled by C. E. Siebenthal, of the United States Geological Survey, Department of the Interior, from reports submitted by all zinc smelters operating during the first six months of 1917 show that the production of spelter from domestic ore in that period was 311,539 short tons and from foreign ore 49,599 short tons, a total production of 361,138 tons, compared with 351,004 tons for the last half of 1916 and 316,452 tons for the first half.

The output of spelter by Illinois smelters increased about 4000 tons for the six-months period, and that of Oklahoma over 14,000 tons, but the production of Kansas fell off nearly 25,000 tons as a result of the declining price of spelter combined with the high cost of natural gas and other fuel. The remaining spelter-producing

States made a large gain, especially Pennsylvania. The output of primary electrolytic spelter also made a good gain.

The number of retorts at zinc smelters at the close of 1916 was 219,418, and there were then building or planned 13,632 additional retorts, a total of 233,050. The number at smelters June 30, 1917, was 232,202, and about 15,000 additional retorts were building or planned a total of over 247,000 retorts.

Owing to the low price of spelter at the close of the first half of 1917, many smelters were idle, either wholly or in part. More than 35,000 retorts were idle June 30, 1917, and this number does not include retorts engaged in refining prime Western spelter or in redistilling zinc ashes and skimmings. Fourteen plants were wholly idle.

Electrolytic Zinc in Utah

The process used by the Judge Mining & Smelting Co., Park City, Utah, for the production of electrolytic zinc, is briefly outlined by Mr. C. A. HANSEN in the recent annual report of the company. The zinc concentrates produced at the company's concentrator contain some lead and silver. They are treated first in a Wedge roasting furnace. The roasted ore is then leached by agitation with an eight per cent sulphuric acid solution in Deveroux tanks. The leach-tank product is discharged to classifiers for the removal of the coarse insoluble material. The solution and fine suspended solids which flow from the classifier are treated in a Dorr thickener, the underflow from which is sent to an Oliver filter. The coarse and fine solids thus recovered from the classifier and filter are sold to lead smelters for the recovery of lead and silver.

The leach liquor contains impurities in the form of copper and cadmium which are dissolved from the ore, and these are removed before the zinc is recovered. The removal of impurities is accomplished by passing the liquor through tube mills filled with zinc shot on which the copper and other metals are precipitated in spongy form. The solution flowing from the tube-mills is filtered and is then ready for treatment in the electrolytic cells.

The cell room, a view of which is shown in the accompanying illustration, contains 120 cells arranged in two groups of 60 each. Each group is served by a gener-

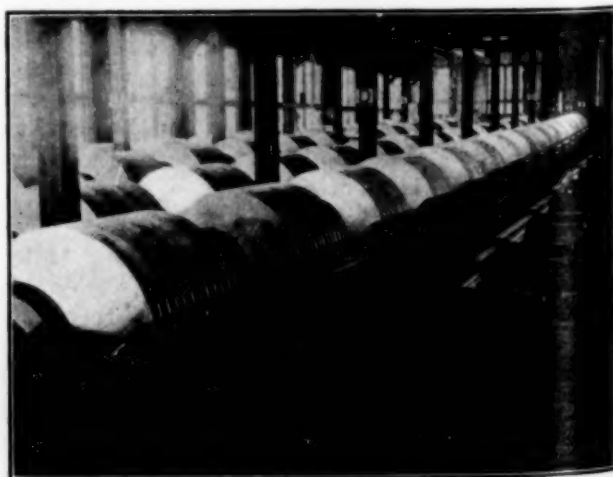


FIG. 1. CELL ROOM, JUDGE ELECTROLYTIC ZINC PLANT

ator delivering 5000 amperes at 250 volts. Each cell carries 12 aluminum discs, five feet diameter, mounted on a rotating shaft. Alternating with the aluminum cathodes are 13 lead anodes which are supported independently of the shaft. Zinc is deposited on the rotating cathodes, and in the course of about three weeks each cell of 12 discs collects about 5000 lb. zinc. The loaded shaft is removed, the zinc stripped, and the shaft reassembled for return to the cell. The electrolytic zinc is melted, cast into cakes and marketed. The electrolyte is again used in leaching roasted ore.

The Jay Bird Mill, Century, Oklahoma

The extent to which Joplin milling methods have been adopted in the new Miami district, Oklahoma, is indicated in the following description of the Jay Bird mill of the Commerce Mining & Royalty Co., kindly furnished by Mr. W. M. GARRED, superintendent. The Miami district is more fortunate than Joplin in that the grade of ore is higher, and there is every hope of weathering any reasonable slump in concentrate prices such as has harrassed Joplin operators for some time past.

At the Jay Bird mill, a flow-sheet of which is shown in the accompanying sketch, the ore is dumped on a 5-in. grizzly where chunks of barren country rock are hand-picked and the balance sledged through, falling into the 200-ton-mill hopper. From here the material passes through a 16-in. jaw crusher (Rogers, Joplin type) set at about $1\frac{1}{2}$ in. opening. Without intermediate screening the crushed ore is run through 36-in. rolls set immediately below and in front of the crusher. The

broken dirt is then raised in elevator (1) fitted with buckets 7 in. by 20 in., and screened through a $\frac{3}{8}$ -in. trommel 4 ft. diameter and 8 ft. long.

The $\frac{3}{8}$ -in. undersize goes to a 6-compartment rougher jig, a large Cooley machine of the fixed-sieve type. Since the feed is unclassified, a bed of coarse particles several inches deep is formed on the grates by the pulsating water, the bed acting as a screen. The downward suction of the water draws the fine mineral into the hutch, from which it is discharged to the "smitten" elevator and thence to the cleaner jig. The bed products of the first two compartments are drawn off as coarse concentrates, while the bed products of the last four compartments join the oversize of the $\frac{3}{8}$ -in. screen. This oversize passes through one of a pair of 30-in. rolls, is elevated (2) and screened through a $\frac{5}{16}$ -in. trommel, 4 ft. diameter and 8 ft. long. The oversize is crushed in 36-in. rolls and returned to elevator (2).

The $\frac{5}{16}$ in. undersize is fed to a "regrind" jig of six compartments, the tailings from which are wasted. No bed product is made and the hutch products join those of the rougher jig in the smitten elevator (3), and are charged as feed to the 6-compartment cleaner jig without further crushing. The first five hutch products and the first three bed products from this machine are finished concentrates. All tailings are crushed in 30-in. rolls, elevated in "chat" elevator (4) and screened through a $\frac{1}{8}$ -in. trommel. The oversize from this is returned to the circuit. The $\frac{1}{8}$ -in. undersize is fed to a 4-compartment sand jig, where concentrates are drawn from the hutches. The jig tailing is settled in a pair of

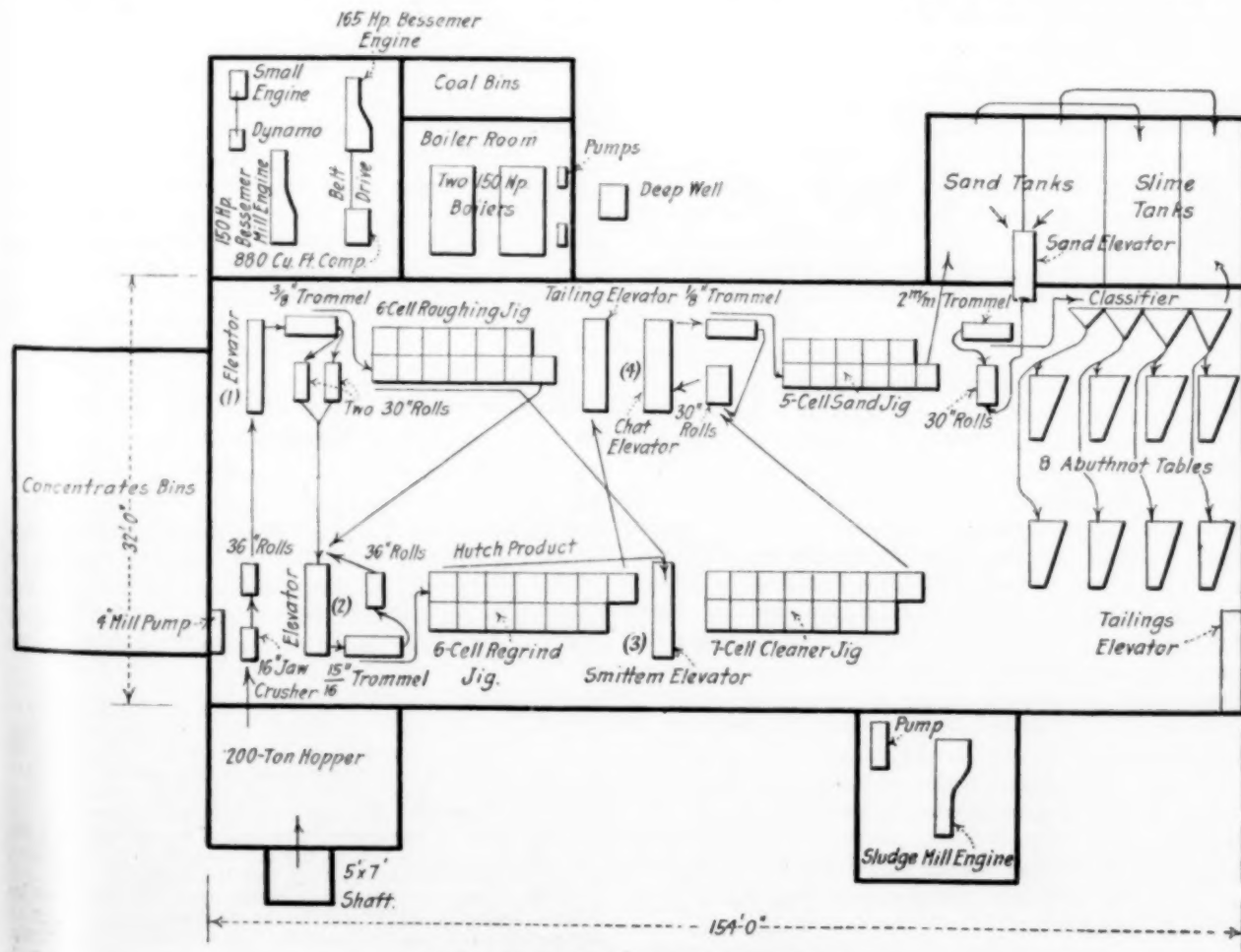


FIG. 2. FLOW SHEET OF JAY BIRD MILL

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Owing to the low price of spelter at the close of the first half of 1917, many smelters were idle, either wholly or in part. More than 35,000 retorts were idle June 30, 1917, and this number does not include retorts engaged in refining prime Western spelter or in redistilling zinc ashes and skimmings. Fourteen plants were wholly idle.

Electrolytic Zinc in Utah

The process used by the Judge Mining & Smelting Co., Park City, Utah, for the production of electrolytic zinc, is briefly outlined by Mr. C. A. HANSEN in the recent annual report of the company. The zinc concentrates produced at the company's concentrator contain some lead and silver. They are treated first in a Wedge roasting furnace. The roasted ore is then leached by agitation with an eight per cent sulphuric acid solution in Deveroux tanks. The leach-tank product is discharged to classifiers for the removal of the coarse insoluble material. The solution and fine suspended solids which flow from the classifier are treated in a Dorr thickener, the underflow from which is sent to an Oliver filter. The coarse and fine solids thus recovered from the classifier and filter are sold to lead smelters for the recovery of lead and silver.

The leach liquor contains impurities in the form of copper and cadmium which are dissolved from the ore, and these are removed before the zinc is recovered. The removal of impurities is accomplished by passing the liquor through tube mills filled with zinc shot on which the copper and other metals are precipitated in spongy form. The solution flowing from the tube-mills is filtered and is then ready for treatment in the electrolytic cells.

The cell room, a view of which is shown in the accompanying illustration, contains 120 cells arranged in two groups of 60 each. Each group is served by a gener-

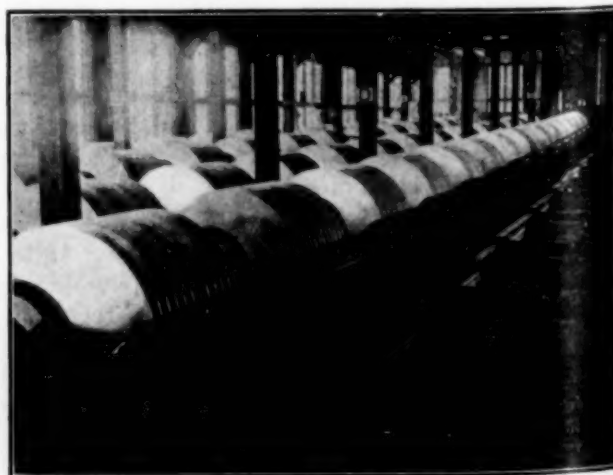


FIG. 1. CELL ROOM, JUDGE ELECTROLYTIC ZINC PLANT

ator delivering 5000 amperes at 250 volts. Each cell carries 12 aluminum discs, five feet diameter, mounted on a rotating shaft. Alternating with the aluminum cathodes are 13 lead anodes which are supported independently of the shaft. Zinc is deposited on the rotating cathodes, and in the course of about three weeks each cell of 12 discs collects about 5000 lb. zinc. The loaded shaft is removed, the zinc stripped, and the shaft reassembled for return to the cell. The electrolytic zinc is melted, cast into cakes and marketed. The electrolyte is again used in leaching roasted ore.

The Jay Bird Mill, Century, Oklahoma

The extent to which Joplin milling methods have been adopted in the new Miami district, Oklahoma, is indicated in the following description of the Jay Bird mill of the Commerce Mining & Royalty Co., kindly furnished by Mr. W. M. GARRED, superintendent. The Miami district is more fortunate than Joplin in that the grade of ore is higher, and there is every hope of weathering any reasonable slump in concentrate prices such as has harrassed Joplin operators for some time past.

At the Jay Bird mill, a flow-sheet of which is shown in the accompanying sketch, the ore is dumped on a 5-in. grizzly where chunks of barren country rock are hand-picked and the balance sledged through, falling into the 200-ton-mill hopper. From here the material passes through a 16-in. jaw crusher (Rogers, Joplin type) set at about 1½ in. opening. Without intermediate screening the crushed ore is run through 36-in. rolls set immediately below and in front of the crusher. The

broken dirt is then raised in elevator (1) fitted with buckets 7 in. by 20 in., and screened through a $\frac{3}{8}$ -in. trommel 4 ft. diameter and 8 ft. long.

The $\frac{3}{8}$ -in. undersize goes to a 6-compartment rougher jig, a large Cooley machine of the fixed-sieve type. Since the feed is unclassified, a bed of coarse particles several inches deep is formed on the grates by the pulsating water, the bed acting as a screen. The downward suction of the water draws the fine mineral into the hutch, from which it is discharged to the "smitten" elevator and thence to the cleaner jig. The bed products of the first two compartments are drawn off as coarse concentrates, while the bed products of the last four compartments join the oversize of the $\frac{3}{8}$ -in. screen. This oversize passes through one of a pair of 30-in. rolls, is elevated (2) and screened through a 5/16-in. trommel, 4 ft. diameter and 8 ft. long. The oversize is crushed in 36-in. rolls and returned to elevator (2).

The 5/16 in. undersize is fed to a "regrind" jig of six compartments, the tailings from which are wasted. No bed product is made and the hutch products join those of the rougher jig in the smittem elevator (3), and are charged as feed to the 6-compartment cleaner jig without further crushing. The first five hutch products and the first three bed products from this machine are finished concentrates. All tailings are crushed in 30-in. rolls, elevated in "chat" elevator (4) and screened through a 1/8-in. trommel. The oversize from this is returned to the circuit. The 1/8-in. undersize is fed to a 4-compartment sand jig, where concentrates are drawn from the hutches. The jig tailing is settled in a pair of

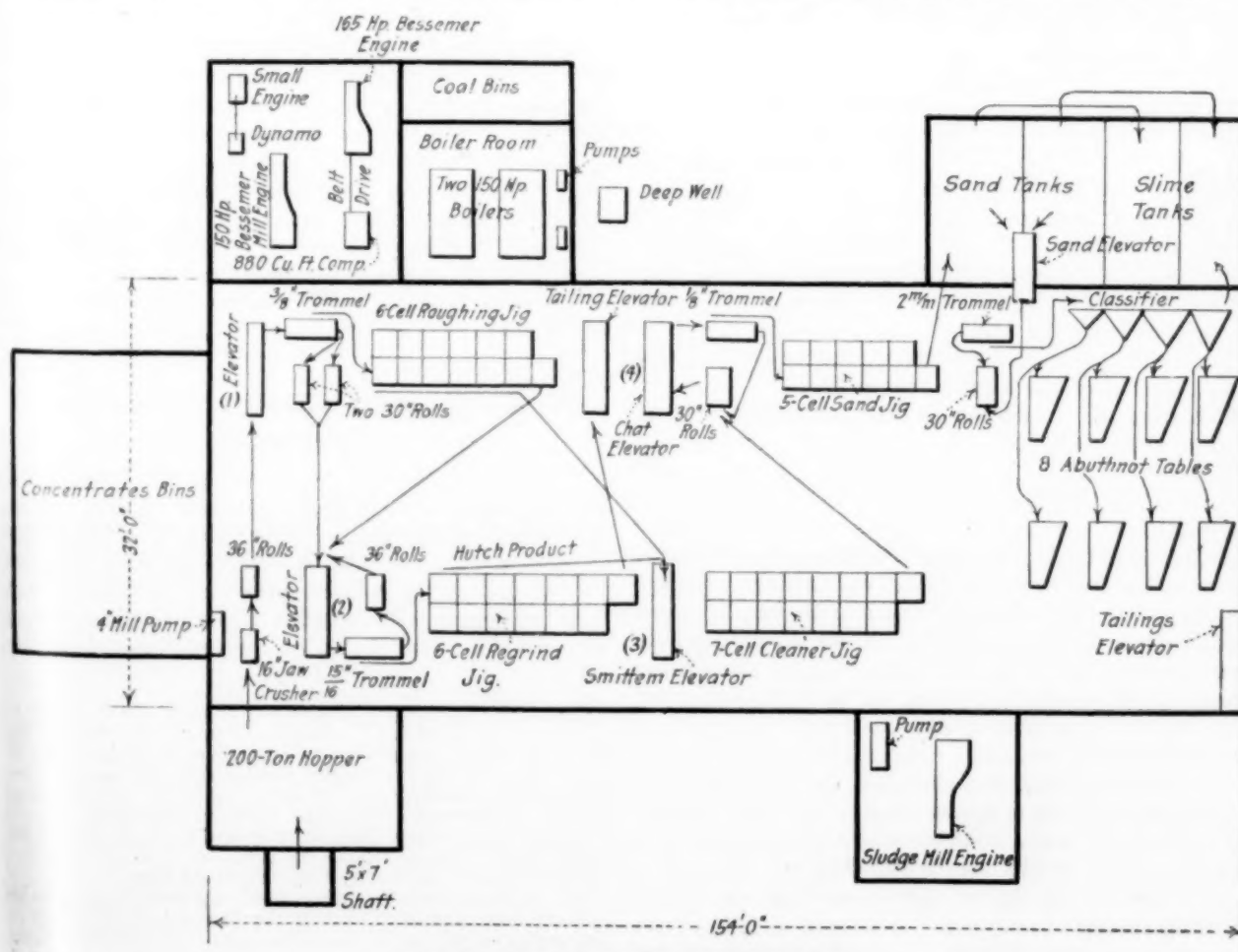


FIG. 2. FLOW SHEET OF JAY BIRD MILL

tanks, the first of which catches sand, while the second recovers the fine slime in the overflow.

The sand tank discharges to an elevator (5). The material is screened through a 2-mm. screen, the oversize being crushed in 30-in. rolls and returned to the circuit. The screened material, together with the slime from the second tank, is discharged into a 4-compartment V-tank, each spigot of which feeds a pair of tables. The V-tank overflow is returned to the settlement tanks. The table makes a clean lead concentrate, a clean zinc concentrate, a mixed lead-zinc-iron middling which is returned to the classifier, and a tailing which is wasted.

The capacity of the mill is 25 tons per hour, and it is operated 10 hours daily. The labor in the mill proper consists of the following:

	Per day.
Millman	\$6.00
First helper	3.75
Second helper	3.50
Sludge man	4.00
Helper	3.50
Feeder	3.65

The average content of zinc in the ore as hoisted is about 7 per cent, while the tailing runs about 2 per cent, making what is called a "5 per cent recovery," or a 20:1 ratio of concentration. The diagrammatic plan gives an idea of the layout of the machinery as well as of the flow of the products.

Company Reports

The annual report of the Granby Consolidated Mining, Smelting & Power Co., Ltd., for the year ended June 30, 1917, covers a period in which the management of the various properties was confronted by numerous difficulties of an unusual character. The business for the year showed a gross profit of \$5,776,875, against which a charge was made for depreciation of equipment and depletion of ore amounting to \$1,580,346, leaving a net profit of \$4,196,529. Four dividends were paid, aggregating \$1,349,961. The average New York price received for copper was 27.4 cents per pound. The cost of delivering copper in New York was 11.5 cents per pound from the Hidden Creek property and 20.8 cents from Phoenix. These figures compare with 10.09 cents and 14.25 cents respectively in 1916.

Metallurgical conditions at the company's Anyox smelter have been good. The loss of copper in slag was 0.23 per cent and the actual recovery was 87.7 per cent. The high cost per pound of copper is due to the high wages and increased cost of supplies, the latter averaging 40 per cent. At the Grand Forks smelter difficulty in operation was experienced due to shortage of coke, and the prospect is that fewer furnaces can be operated than in the past. This will mean an increase in operating cost even under normal conditions. To assure the company an adequate supply of coal and coke, steps are being taken to acquire coal land and to construct a by-product coke plant.

The beneficial results of the safety work of the company is shown in a comparative statement of average time lost per accident. In 1914 the average time lost was 33 days; during the 15 months ended April 1, 1916, this was reduced to 19½ days; in the 15 months ended June 30, 1917, 11 days.

Butte & Superior Mining Company's annual report for 1916 shows a net profit for the year amounting to

\$8,792,131 and dividends paid amounting to \$9,490,429. Estimate of ore reserves as of December 31, 1916, shows 1,044,850 tons of ore averaging 17.7 per cent zinc and 5.65 oz. silver. Improvements and extensions were made during the year in every department of the milling plant. An entirely new coarse-crushing and storage department was constructed, and the capacity of the fine-crushing plant was increased. Important additions were made for handling slime and concentrate, with a view to recovering the maximum amount of water. Total ore milled amounted to 627,370 tons, an increase of 105,000 tons over the previous year. The average metal content of ore milled was 15.55 per cent zinc and 6.57 oz. silver. Mill recovery averaged 93.1 per cent of the zinc, an increase of nearly 1 per cent above the result for 1915. Costs increased abnormally, due wholly to higher wages and cost of supplies.

The quarterly report of the same company for the second quarter of 1917 gives the following principal operating data:

Dry tons of ore milled	126,737
Average zinc content (per cent)	15.55
Average silver content (oz. per ton)	5.5838
Zinc concentrates produced (tons)	37,670
Average zinc in concentrates (per cent)	46.509
Total zinc in concentrates (pounds)	35,039,604
Average silver in zinc concentrates (oz. per ton)	17.674
Mill recovery (per cent zinc)	90.329
Mining costs (per ton)	\$4.7594
Milling costs (per ton)	\$2.4661
Total costs (per ton) mining and milling	\$7.2255

The above statement does not take into account the returns from or costs of treatment of 6325 tons of old mill tailings which produced 337 tons of concentrates containing 277,081 pounds of zinc. The tonnage of ore mined and treated fell considerably below that of the first quarter, very largely because of the unsettled labor conditions during almost the entire month of June. The average recovery of metals in concentration shows an improvement over that of the previous quarter, and the total cost of mining and milling, exclusive of taxes, decreased 18 cents per ton, due in part to a better adjustment of the milling operations. Replenishment of ore reserves by development amounted to 142,489 tons, or a net increase over the tonnage mined for the quarter of 17,500 tons.

Greater Co-operation with the Railways Needed

Mr. R. H. Aishton, president of the Chicago & Northwestern Railway and chairman of the Central Department of the Railroads War Board, addressed the convention of Associated Business Papers at Chicago on Oct. 12, on the railway situation. He brought out some important points which are given in the following extracts and which should be carefully considered. He said:

"In order to get more service out of each car they had to secure the co-operation of shippers in loading and unloading cars more promptly and in loading them more heavily. To save men and fuel for freight service they had to make reductions in passenger service which, up to the present time, amount to 25,000,000 passenger train miles a year.

"In order to secure the good will and co-operation of the public in doing these things the railroads had to get before the public the reasons why they had to be done.

"If the demands now being made upon the railways by military and commercial traffic should continue as heavy as they now are, or even increase for some time as it now seems probable that they will, the task of the railways is going to grow more and more difficult.

"The railways are working every locomotive and car and track to the utmost now. Shortage of labor and material make it extremely difficult to maintain adequately our present equipment, while it is practically impossible to get new equipment. It is almost impossible to get rails and other track materials to replace those being worn out.

"You will readily see what all these things mean. They mean that if the war goes on it is going to become more and more difficult for the railways to meet satisfactorily the demands on them. If this is the case the railways will need the help of the press more and more. They will need it in presenting the facts about railway conditions to the public, in urging the public to co-operate with the railroads in all the ways that it can and also in urging the public to be tolerant regarding any delays and inconveniences to which it may be subjected.

"I do not suggest that you gentlemen of the business press should do this for the benefit of the railways, for I know you are not specially concerned with the welfare of the railways. But you are specially concerned regarding the welfare of the great industries with which you are identified, and you are more vitally concerned for the welfare of your country.

"One of the most effective ways in which you can serve those industries and your country in this great emergency is by using your powerful influence to get the business interests to co-operate with the managements of the railways in every way they can so as to enable the railways to handle the unprecedented traffic which is now moving and which, so far as we can see ahead, will continue to move for months to come."

Gas and Flame Service Regiment

The commanding officer of the Thirtieth Engineers has issued a call for men to serve in the "Gas and Flame" Division.

This regiment is being recruited now from men volunteering for the service and will be ready to go "over there" by Thanksgiving.

The regiment will be required in the field of operation to supervise the American offensive in "Gas and Flame" service and will be called upon to instruct men all along the front in this most important work.

The Thirtieth is the pioneer regiment in the "Gas and Flame" service. Men who enlist now will be leaders in the spring offensive.

Chemists (analytical, research and manufacturing). Chemical workers, powdermen, men experienced in gas manufacture, machinists, automobile repair men, men able to operate and repair gas or steam engines, pipe fitters, electricians, designers, interpreters, carpenters, blacksmiths, plumbers, boiler-makers and chauffeurs are wanted.

Men with long experience in their trade are especially desired to fill the master engineer grades.

All men enlisted in the Thirtieth must have good muscular development and be capable of undergoing active service at the front.

Men are wanted who know how to take care of themselves, who are active, energetic, and have a strong determination to carry out any mission to which they may be detailed.

Loyal American citizens with the above qualifications between 18 and 40 years of age, who have not actually been called by a local board in the draft, are eligible for enlistment.

Col. A. A. Fries, Engineers, N. A., is to be the commanding officer of the Thirtieth Engineers. He is a regular officer of the Corps of Engineers, with many years' experience in military and civil engineering. Colonel Fries is now in France and is "Chief of the Gas Service."

Major E. J. Atkisson, Corps of Engineers, is organ-

izing the first battalion of the Thirtieth Engineers at Camp American University, D. C. He is a graduate of West Point and of Cornell University.

In order to enlist it is only necessary to go to the nearest recruiting station or U. S. District Engineering Office, state fully and clearly your qualifications and that you wish to be enlisted in the Thirtieth Regiment of Engineers (Gas and Flame).

All men must first enlist as privates, the rate of pay being \$33 per month and expenses. Men with the necessary experience may be assigned to special duties and given non-commissioned rank at rates of pay ranging from \$40.20 to \$96 per month and expenses. The latter include, for both privates and non-commissioned officers, food, clothing, medical attendance and transportation. Those who enlist will be eligible immediately for promotion, according to their ability and as openings occur.

Manufacturers are requested to bring this notice to the attention of their organizations.

American Coal Tar Products Production to Be Ascertained by the Tariff Commission

The United States Tariff Commission is planning to ascertain the production within the United States during 1917 of all substances treated in Title V of the Special Tariff Act of Sept. 8, 1916. The substances there enumerated may be classed under the general name Coal Tar Products, and are divided into three groups.

Group I includes "all products that are found naturally in coal tar, whether produced or obtained from coal tar or other source," except phenol. These substances are admitted free of duty.

Group II includes the so-called intermediates, and are made dutiable at 15 per cent plus 2½c. per pound.

Group III includes "all colors, dyes, or stains, whether soluble or not in water, color acids, color bases, color lakes, photographic chemicals, medicinals, flavors, synthetic phenolic resins or explosives, not otherwise specially provided for in this title, when obtained, derived or manufactured, in whole or in part, from any of the products provided for in groups I and II." These articles are dutiable at 30 per cent plus 5c. per pound, with certain exceptions which are dutiable at 30 per cent.

Under the law the duties are made dependent on the growth of the industry within the United States. It is, therefore, the intention of the commission to follow this growth from year to year in order to report the facts to Congress.

The Tariff Commission is planning to send to each manufacturer a questionnaire calling for information in regard to his production during 1917 of each separate commodity, as well as for certain other data. This information will be published in such a form that the operations of individual firms will not be disclosed. A preliminary questionnaire has recently been sent out, designed to aid in perfecting the mailing list. Any individual or firm engaged in the manufacture of any of these articles which did not receive a copy of the preliminary questionnaire is requested to write to the United States Tariff Commission, Washington, D. C., to insure being placed on the mailing list.

British Munitions Commission Discusses Labor Question

Tells How England Has Fixed Profits and Wages, Suspended Union Rules and Handled Female Labor

An important series of executive conferences was held during the weeks of Nov. 5 and 12 in New York, by the British Munitions Commission, which recently came to this country, and various manufacturers and trade and technical press representatives. The conferences were held under the auspices of the Mayor's Committee. Several of them were held in the Merchants' Association headquarters in the Woolworth Building. Others were held at various places. Sir Stephenson Kent is the head of the commission.

On Friday, Nov. 9, two members of the commission, Messrs. Garrod and Baillie, met representatives of the chemical, drug and allied industries. Both commissioners delivered short addresses, and these were followed by an open round-table discussion which brought out many exceedingly interesting points.

Commissioner H. W. Garrod explained that in March, 1915, when it was felt that some action on the labor question was necessary, the parties who could speak for the industries, i. e., the Employers' Association and the parties who could speak for the trade unions were brought together and the so-called Treasury Conference was held, at which it was agreed that there were to be no strikes or lock-outs in munition works during the war. The Munitions Act was an outcome of these agreements. The unions agreed to abandon all restrictive measures such as favored closed shop and men working at only one trade. Where any dispute arises it is compulsory to submit it to Government arbitration. It was also decided that anyone could be employed during the war, and that after the war the unions will be restored to their former status.

Regulation of Wages

The Government also took up the regulation of wages, and they were fixed definitely and based on the rate in effect in the various districts before the war. Since the war started a million women have been employed in England in munitions work (a term which includes all war supplies). The women receive the same pay as the men on skilled and piece work and two-thirds of the men's wages in other cases, as it was found by experience that three women were needed for two men's jobs on the unskilled work. Only three serious strikes have so far resulted and none of these has been for an increase in wages. The union officials have shown great patriotism in standing by the Government.

Excess Profits to Government

As a large percentage of the profits of the manufacturers had to be paid into the Exchequer, the employers had to have some restrictions on wages. Munitions Tribunals, or domestic courts, were formed at which all offenses of employees or employers are tried.

Engineering and Chemical Industries

Commissioner Baillie in his address said his experience had been mostly with the engineering and chem-

ical industries. By engineering industries he meant machine shops and heavy metal fabrication. A great shortage of labor for these industries—the most important of all—was encountered. This was on account of the skilled labor needed. The schemes adopted to cope with this situation were mainly the dilution of skilled labor, or grading up process, whereby unskilled workmen are taken in and placed on the easy jobs first; and the breaking up of skilled jobs into parts, the least skilled parts being done by the green workmen.

In the shell, fuse, hand grenade and cartridge factories 80 per cent of the laborers are women. Women are also doing skilled work in the production of aeroplanes, guns, etc. They are also doing laboring work of all kinds in the chemical factories and are also handling processes. In picric acid all operations on the drying end are handled by women. In T. N. T. 50 per cent of the laborers are women. In T. N. T. plants the women are required to take two weeks rest after every period of three months' work. Women are working in all operations on fulminate.

An interesting incident was related by Mr. Baillie in connection with a fire which broke out in a picric acid plant. The men all disappeared and the manager with the women put the fire out.

Discussion

In reply to a question on segregation of men and women, Mr. Baillie said it had not been found highly important and was not in force to any extent. Special women superintendents are appointed to look after the welfare of the women employees. He said it was forbidden to entice labor by competitive bidding, and that leaving certificates are issued. These are only for jobs requiring higher skill and are not issued where a man is simply leaving to get more money on the same work. Provision has been made for increasing wages, dependent on the cost of living. A Commission of Productions was organized, whose business it is to look into the cost of living three times a year. Usually an award is given instead of a wage increase where the cost of living warrants it.

Sixty working hours per week is the limit for women. The normal time in explosives work is 48 and in engineering 52 to 54. There is no limit for men. In general the women have been found more careful than the men.

Commissioner Baillie said very few industries were forced to completely shut down, as they could usually find some war work to do, even though in many cases it was not sufficient to keep the factory running to anywhere near capacity.

In regard to conscription of labor it was brought out that England could not conscript labor, but could tell an employer he could not employ certain men, which is almost the same thing. Conscription of labor is not necessary however, as the skilled men, to the number of more than 200,000, have been grouped as "Volunteers of Munitions," which they will continue to be for the time of the war. They willingly go wherever the Government sends them. Too much emphasis, the American employers were told, could not be laid on this willingness of the British worker to serve his country.

Investigation of Manganese Situation

On account of the increasing difficulty in obtaining imported manganese, and the vital importance of manganese for the production of the steel needed in making war, the Bureau of Mines is making a thorough investigation of the possibilities of relief through a more extensive use of domestic ores. On account of the steel industry being dependent on manganese, and on account of the problems of ore concentration being similar to those of iron ore, these investigations have been assigned to the Lake Superior station recently established at Minneapolis. Although the bureau realizes the importance of taking up the iron-ore concentration problems at the Lake Superior station as soon as possible, yet such work is obviously to be classified among the "peace-time problems" relating to conservation; whereas the manganese investigation, under present conditions, is strictly a "war problem" dealing with increased production.

The Lake Superior region is an important producer of manganiferous iron ores; it contains large reserves of these ores, and can mine and ship much larger amounts if metallurgical practice can be so modified as to make ores in better demand.

For many years our steel makers have relied on manganese alloys imported from England, and on manganese ores from India, Russia and Brazil. These imported ores are high in manganese and are suitable for making 80 per cent ferromanganese, the alloy that has been desired in greater quantities because of a larger proportion of our steel being made by the open-hearth process.

With the low ocean freight rates that prevailed generally during the 10 or 20 years, it was well-nigh impossible for producers of domestic manganese ore to compete with imported ore. Consequently the manganese industry of the United States languished. There was little or no incentive for the exploration and development of manganese ore bodies and their mining was carried on without system.

WAR CHANGES CONDITIONS

With the outbreak of the war in Europe in 1914 the manganese industry of the world faced new conditions. The entrance of Turkey into the war cut off shipments of the Russian ores from the Caucasus region. A growing scarcity of available ocean tonnage has made it increasingly difficult to transport the material from the usual producing countries, and the great rise in ocean freight rates has increased the cost of imports. Consequently, producers in the United States face an unprecedented demand.

Until last year this demand had little if any effect on production because of the difficulty of interesting capital in an industry that might die with the ending of the war. A clearer and broader conception of the causes of high manganese prices, and a belief in the likelihood of these causes existing for some time after the close of the war, has partly removed that tendency. A far greater difficulty in obtaining domestic supplies is the fact that manganese ore of high grade, suitable for making 80 per cent ferro, is very scarce in the United States, manganiferous iron ores being much more abundant. Such ores have not been in much demand by the steel industry in the past, and it is

essential to investigate carefully, by research on a large scale, the possibilities and limitations involved in their use. It is this work that the Bureau of Mines desires to carry out as rapidly as possible. The sooner the facts can be determined the more valuable they will be.

The bureau realizes that much information has been accumulated by various Federal and State bureaus, technical societies, private operators, and individuals. Duplication of present effort and of any reliable results already obtained must be avoided in order that the Bureau of Mines may devote its time to questions that have not been clearly answered as yet. For this reason the bureau hopes to work in a spirit of cordial cooperation with all agencies interested in the problems to be solved, with producers and consumers of manganese ore and alloys and with individuals. Such cooperation is essential in order to serve the country well in the effective conduct of the war. A proper co-ordination of all data now available and of the data obtained in attacking these problems will be of tremendous assistance. Proper credit for such cooperation and assistance will be gladly given wherever possible. Suggestions and constructive criticism will be greatly appreciated.

The bureau plans to assemble and tabulate as much information as possible concerning the character and available tonnage of known domestic ores, the current practice in mining and concentration, and the present methods of manufacturing manganese alloys and of using them in steel. When compiled, this material should afford a starting point for various original researches dealing with related problems.

The possibility of concentrating various types of ores will be studied by detailed tests and experiments, fundamental thermo-chemical data relating to manganese and its compounds will be determined, and the equilibria of certain fundamental reactions between iron and manganese compounds will be studied. Also much attention will be given to the development of possible substitutes for manganese in steel making; to the possibility of using more extensively alloys that are not used in what is now considered standard practice, such as alloys containing between 20 and 80 per cent manganese, and alloys containing manganese and other constituents, and to the possibility of increasing the manganese content of basic pig iron in order to lessen the amount of manganese alloy added at the end of a heat, part of this being left as residual manganese in the bath metal. Another problem that will be studied in the light of the results already obtained will be the production of manganese alloys in the electric furnace in localities where power is cheap. During the past summer the bureau has been carrying on a series of experiments in Pittsburgh on the production of alloys in the electric furnace from slags high in manganese.

Much of the work relating to present practice, also certain researches, must necessarily be conducted in the field at mines, concentrating plants, blast furnaces and steel works. In the laboratories of the Lake Superior station, which is situated at and co-operates with the University of Minnesota, at Minneapolis, concentration tests of ores will be made and fundamental laboratory data will be collected. Arrangements are now in progress for co-operative work on other problems at

laboratories throughout the country that are equipped to do work of the desired character.

The persons actively engaged in these manganese investigations will comprise the staff of the Bureau of Mines attached to the Lake Superior station, the staff of the Minnesota School of Mines Experiment Station, and those members of the Bureau of Mines who may be particularly qualified for certain phases of the work. In order to make this work of the most practical value it is planned to organize a number of advisory committees composed of mine and furnace operators.

Conserving and Increasing Supplies of Foodstuffs

New York Section of American Chemical Society Holds Interesting Meeting

The second regular meeting of the season of the New York Section of the American Chemical Society was held at the Chemists' Club on Friday evening, Nov. 9. The chairman, Dr. CHAS. H. HERTY, presided.

A few business matters were disposed of before the program was given. Dr. ALLEN ROGERS reported on the work of the Press and Publicity Committee, which has been doing such splendid work in getting chemistry and its value before the public. The chairman appointed Drs. LOVE and TEEPLE and Professor MCKEE as a nominating committee to nominate local councillors.

The first paper on the program was by H. A. BAKER of the American Can Company, who spoke on the canning industry and pointed out several ways of conserving and increasing foodstuff supplies. He mentioned especially the important experimental work of the National Canners' Laboratory in decreasing the amount of tin required in tin cans and in solving many of the problems relative to the canning process proper. He mentioned the great waste in the canning industry in peels, corn cobs, etc.

"At present," Dr. BAKER said, "only 50 per cent of tomatoes delivered at the factory are turned out in the canned food product. Thousands of tons of pear peelings are wasted because they do not make a vinegar that tastes like vinegar. Thousands of tons of fish scrap, particularly on the Pacific Coast and Alaska, are wasted because easy and profitable methods of getting the values out of them have not been devised. Enormous quantities of green corn cobs are allowed to ferment, and are used for fertilizer and cattle food, when it is well known that there is more sugar left in the cob than was taken off in the corn.

"Probably many kinds of bacteria which only destroy food could be made to do useful work producing useful substances and chemicals, if they were thoroughly studied and put to work. Enormous quantities of sea food, which cost nothing to grow, are unused because no one has prepared them palatably and attractively. Unlimited quantities of shark and grayfish are not used because they happen to contain a small quantity of urea which, in cooking, turns into ammonia."

In reply to a question, Mr. BAKER said that aluminium-lined containers would not be practical owing to the difficulty in soldering. Enameled cans, he said, reduce absorption of metal. The enamel is put on over the tin and baked at 370 deg. Fahr. It is a linseed-oil-gum product.

The subject of cotton oil and other edible oils was discussed by Dr. DAVID WESSON of the Southern Cotton Oil Company. He said the edible fat problem was an extremely important one. Our increased production of peanut has somewhat offset the decreased cotton oil production, as have also increased imports of soya bean and coconut oil. The supply, however, of edible oils will not be large enough unless the strictest economy is used. Dr. WESSON advises that edible oils should not be used in soaps and other industrial lines where substitutes can be found. He also mentioned a number of products which should find greater use, such as oleomargarine and cheese made from skimmed milk and cottonseed oil. He said that chemists should point out to Congress the harm in existing food laws in taxing and limiting the use of perfectly good and wholesome substitutes.

Upon motion of Dr. JEROME ALEXANDER, it was decided to recommend to the President and council of the society that some action be taken in the matter just referred to.

Dr. T. B. WAGNER said that corn oil is now being converted into edible oils. About 150,000,000 bushels of corn per annum are used in the corn products industry and 1-1½ lb. of oil per bushel can be obtained.

The other papers were by J. A. LECLERC of the Laboratory of Plant Chemistry in Washington and L. P. BROWN, J. T. ATKINSON and THOS. MCMEKAN of the Bureau of Foods and Drugs, New York City.

Sulphur and Pyrite in 1916

The Geological Survey has recently completed the compilation of statistics regarding the production of sulphur, pyrite, and sulphuric acid in the United States in 1916. The last named has been given in a previous issue.

No statistics regarding the production of sulphur will be made public, as 99 per cent of the sulphur produced in the United States came from only two companies. The importations of sulphur were practically the same as for the last five years, amounting to 22,235 long tons, valued at \$404,784. The exports, however, increased nearly 350 per cent over the exports in 1915, amounting to 128,755 long tons, valued at \$2,505,857.

Never before was so much pyrite produced or imported by the United States and prices for this material increased throughout the year. The increase in production is to be attributed mainly to the greater yield from old mines rather than to the opening up of new deposits. The domestic production of pyrite in 1916 was 423,556 long tons valued at \$1,965,702, which is about 30,000 long tons more than was produced in 1915 and was valued at about \$290,000 more than the ore produced in 1915. The consumption of pyrite ore—that is, the domestic production together with the ore which was imported, amounted to about 1,670,000 long tons. In addition to the pyrite ores reported here, returns from acid manufacturers show that 577,045 long tons of domestic copper-bearing sulphide ores; 196,404 long tons of foreign copper-bearing sulphide ores; 531,625 long tons of domestic zinc sulphide ores; and 92,002 long tons of foreign zinc sulphide ores were treated in 1916 for their sulphur as well as for their metallic content.

Regulation of Explosives Goes Into Effect

President Wilson has issued a proclamation relative to the Explosives Act passed by Congress and approved by him on Oct. 6, 1917. In this act it is provided among other things that from and after forty days after the passage and approval of said act no person shall manufacture, distribute, store, use, or possess explosives or ingredients thereof, not including explosives for the military or naval service of the United States of America under the authority of the government or ingredients in small quantities not used or intended to be used in the manufacture of explosives, and not including small arms or shotgun cartridges, unless such person shall obtain a license issued in the name of the Director of the Bureau of Mines, except that any workman may purchase or accept explosives or ingredients thereof under prescribed conditions from a licensed superintendent or foreman. The Director of the Bureau of Mines is also authorized to utilize the various federal, state and municipal officers, agents and agencies in the execution of the act.

According to the President's proclamation, the law is to take effect November 16, 1917, and continue in force during the war.

Mr. Francis S. Peabody of Chicago, a well known coal operator familiar with the use of explosives, large amounts of which are used in the coal mining industry, has been appointed by Secretary of the Interior Lane to act as assistant to the Director of the Bureau of Mines Van H. Manning in the enforcement of the law. The police of the cities have already been organized for this work, headed by a committee of chiefs of police in the big cities, of which Major R. W. Pullman, superintendent of police of Washington, D. C., is chairman. The police are not only to look after the enforcement of the law, but are also to make thorough investigations of all dynamite outrages and fires in factories and warehouses and to make their reports to the Director of the Bureau of Mines.

The law provides that everyone who handles explosives must have a license. The manufacturer, the importer and the exporter must have licenses issued by the Bureau of Mines in Washington. The seller of explosives and the purchaser of explosives must also have licenses, these to be issued generally by county clerks, or other local officers who are authorized to administer oaths. There will be at least one licensing officer in each county, and more agents will be designated if the county is sufficiently large to warrant it. If a state has laws providing for a system of licensing persons manufacturing, storing, selling or using explosives, the state officials authorized to issue such state licenses shall be designated as federal licensing agents; also city officials qualified to issue city explosives licenses will be given authority to issue federal licenses. A federal license will not relieve any person from securing licenses required under state laws and local ordinances.

In each state there will be appointed a state explosives inspector, who will represent the Bureau of Mines in the administration of the law within the state.

Only citizens of the United States or of countries friendly to the United States and the Allies may so obtain licenses.

Contractors, mining companies, quarrymen and others

using large quantities of explosives, which are handled by employees, may issue explosives to their employees only through those employees holding a license, called a foreman's license.

The purchaser of dynamite, in obtaining a license, must state definitely what the explosive is to be used for and will be held accountable for its use as stated and the return of any explosives that may be left.

A New Government Employment Service

The United States Department of Labor recently created, as a part of its employment service, a division whose function it is to aid the employer in obtaining suitable help, and professional persons in securing suitable employment. This is known as the Teachers and Professional Service Division. While intended to embrace all professions, attention has thus far been confined to the teaching and engineering professions. The services of the Division are absolutely free to both employer and employee, all expenses being borne by the United States Government. Its methods are quite thorough, and no service is rendered the applicant until the Division has learned, from persons familiar with the applicant, that he is qualified as to training, experience and personal qualities for the position he seeks. When an applicant is recommended for a reported vacancy, the employer is given an opportunity to examine the data gathered in the course of this investigation, thus effectually preparing for the final and most important step, the personal interview, and for this ample facilities are provided in the offices of the Division where employers may meet with prospects on appointment.

Employers and professional engineers everywhere are invited to avail themselves to the services of this Division which, as stated above, are entirely free. Employers in reporting positions are asked to state the nature of the position, its duties, requirements, etc., the probable salary, and probable duration of employment. Applicants for registration should indicate in the first letter the nature of the position desired so that the proper blank may be furnished. All communications should be addressed: Teachers and Professional Service Division, U. S. Employment Service, 845 South Wabash Avenue, Chicago, Illinois.

New Tennessee Potash Plant

Work has been started on the new potash-recovery plant of the Clinchfield Portland Cement Corp., at Kingsport, Tenn. This plant will employ the Cottrell or electrical precipitation system in its latest form, and will include a wet treater by means of which potash salts will be obtained. Incidentally, it may be said that the wet treater is not only less expensive to install than the dry treater heretofore employed, but the potash salts obtained by it bring a much higher price per unit than the potash-bearing dust from the hydrator. There will also be a much better market for the salts than for the dust after the war is over and the German product comes back to this country. In the plant at Kingsport the engineers have worked out a system by means of which the evaporation of the solutions will be effected by means of the waste heat from the kilns. Richard K. Meade & Co., consulting engineers of Baltimore, Md., are the designing and constructing engineers for the plant.

The Use of Enemy-Owned Patents

In our semi-monthly review of recent metallurgical and chemical patents issued by the United States we have continued to publish those of importance which have been granted to citizens of enemy countries. Inquiry received regarding this matter suggests the need of an explanation of the status of enemy-owned patents in this country, as defined by the trading-with-the-enemy act passed by the last Congress. This act contains various provisions as to the application for patents in enemy countries by United States citizens; for the suspension of information as to certain patent applications made in the United States where secrecy is necessary for military reasons; and for the use in this country by our citizens of enemy-owned patents during the period of the war.

The door is not closed against enemy citizens who may wish to secure letters patent in the United States, but provision is made whereby our manufacturers may be licensed to use such patents in their business. The Federal Trade Commission is empowered by the President to deal with these matters, receiving applications and granting licenses. For the privilege of using enemy-owned patents it is necessary to pay to the Custodian of Enemy Property 5 per cent of the value of the products made under such patents. At the close of the war the enemy owner may, within one year, sue for the recovery of royalty on the use of a patent. If the courts grant him the right to recover, the 5 per cent fund shall apply on such royalty; but if the right to recover is denied, then the 5 per cent shall revert to the manufacturer. It seems scarcely probable that enemy citizens will be allowed by their governments to continue to patent important processes and devices in the United States, but if such is the case we are privileged to make use of them under the restrictions outlined.

Cincinnati Meeting of the American Iron and Steel Institute

(Continued from page 524)

Mr. D. B. MEACHEM of the Rogers, Brown & Co., a member of the local committee, spoke on "Cincinnati and Its Industries."

The next paper, entitled "Recent Installations of Large Electric Motors in Rolling Mills," was presented by Mr. S. S. WALES, electrical engineer of the Carnegie Steel Company. In this paper he started with the introduction of electric motors into steel works in 1890, at which time an attempt was made to adopt the street railway type motor to movable machines, such as cranes, and traced the development of the highly specialized type of motor in use at the present day.

He then proceeded to show in what ways the motor replaced the steam engine, and how to-day it is beginning to replace the hydraulic cylinder.

After commenting on the introduction of the steam turbine and its effect on the adoption of main mill motor drives, he considered in detail the various types of motors and drives employed, and discussed the question of standard ratings for large motors. In regard to costs, he showed that while the original outlay may not vary much from that required by a steam plant, however, due to the centralization and higher efficiency

obtained with the turbine and the electric drive, it is possible to make a saving of as high as 50 per cent in the fuel consumption.

In discussing this paper Mr. D. B. RUSHMORE of the General Electric Company, and Mr. W. SYKES of the Westinghouse Electric & Manufacturing Company called attention to the fact that to-day the electric motor has entirely replaced the steam engine for the main mill drive.

In a paper on "Iron and Steel Scrap," Mr. W. V. PHILLIPS contributed much interesting and unusual information in regard to this important but neglected subject. He commented upon the value of scrap, showing how it is based upon supply and demand, and to a certain extent upon the value of the raw products it replaces. He also mentioned the organization known as The American Board of Iron Scrap Dealers and its relation to the government and business at large in trying to standardize the various scrap classifications and eliminate the dishonest dealer.

The afternoon session was opened by Mr. J. G. BUTLER of the Brier Hill Steel Company, who, in an historical and informal manner, touched upon his fifty years' connection with the iron and steel industry.

Mr. H. F. POPE presented a paper on "Malleable Iron and Its Uses." After briefly discussing the casting of the iron and its subsequent annealing, he pointed out the difference between American and European practice. He then proceeded to enumerate the advantages of malleable iron over wrought iron and cast steel, showing the desirability of its use in many places.

Professor ENRIQUE TOUCEDA of Rensselaer Polytechnic Institute, in discussing this paper, called attention to the remarkable similarity in the properties of malleable iron and wrought iron, which are wonderfully close when we consider the great difference in the method of manufacture, and he and Mr. F. J. Lanahan of the Fort Pitt Malleable Iron Company, Mr. F. E. Nulsen of the Missouri Malleable Iron Company, and Mr. J. S. Haswell of the Dayton Malleable Iron Company called attention to the necessity of complete control throughout the process, which is being brought about by its increasing use in the automobile industry.

Mr. NULSEN brought out the point that it was due to the large use of malleable iron that the American automobile was so much lighter than the modern European car.

Both Mr. NULSEN and Mr. HASWELL commented on the great resistance to wear and oxidation of high grade malleable iron, and said that due to this fact and the present abnormal price of steel it was replacing the latter in many places.

A paper entitled "The Export Trade as Affected by the War" was read by Mr. E. P. THOMAS of New York. Mr. Thomas brought out the point that due to the war our capacity for production of steel had increased to such an extent that when the war is over we will have to depend on our export trade to take care of the surplus production. He called attention to the importance of a merchant marine in this respect.

He touched to considerable extent upon the importance of the Minette-Lorraine district in Europe, especially in relation to the terms of peace, proving by statistics that Germany depended upon it for about 80 per cent of its raw material for the iron and steel industry.

The Furnace Refining of Copper

By Lawrence Addicks

In the early days copper was produced by a succession of roasting and fusing operations based upon the fact that copper sulphide when melted with copper oxides react to form sulphur dioxide gas and metallic copper. This was the basis of the celebrated Welsh process. Then it was found that if the operation was so conducted that a small metal fall was obtained first, these "bottoms" would contain most of the impurities, including gold (silver was frequently separated by a sulphatizing roast and subsequent wet extraction), and the balance of the copper produce would be correspondingly purer. This is the characteristic "best selected" process used in England and the basis of the "Argo" process for separating gold from copper.

While converting has supplanted roasting and electrolysis reverberatory refining for the great bulk of the world's copper, although the melting of Lake mineral in Michigan and various small-scale operations abroad are notable exceptions, the electrolytic process has retained two reverberatory steps, the anode and refining furnace operations, in the metallurgical scheme.

Blister copper produced directly by the converter does not make desirable anodes, although special conditions at one refinery has made their use profitable. For the general case the principle has been well established that work which can be done in the anode furnace should not be done in the tank house. The guiding principle in tank-house operation is to do whatever is necessary to obtain uniformity of operating conditions, and converter anodes give trouble unless a very pure blister is being treated.

The function of the anode furnace is to make a perfect anode casting in which the sulphur has been thoroughly removed and other oxidizable impurities slagged off as far as possible.

The refining furnace serves merely to put the cathodes into desired physical shape and beyond the elimination of traces of sulphur and adjustment of "pitch" has ordinarily no chemical function. Nevertheless the methods of operation of the two furnaces are identical in many respects and the discussion of the general principles involved is applicable equally to both.

Just as many of the operations in smelting are based upon the marked affinity between copper and sulphur, so the basis of furnace refining is the relative weakness of the affinity between copper and oxygen. The general plan is therefore to oxidize the impurities the oxides of which will then either escape by sublimation or float on the surface of the bath, from which they may be skimmed or slagged. According to this method it should be possible to remove all elements less noble than copper, leaving simply silver, gold and the platinum group alloyed with the copper. The same principle of resistance to oxidation is reversed in the tank house, the copper oxidizing to sulphate at the anode and the more noble metals remaining behind in the slimes. Theoretically we have, therefore, a perfect separation of the copper, the impurities and the values.

In practice the system does not work out so perfectly, as mass action comes into play. It is quite easy to remove the bulk of most oxidizable impurities in the anode furnace, but as the amount present becomes less and less it is increasingly difficult to make further re-

movals, and carried to absurdity the entire charge would be slagged in order to remove the last traces. Then some elements such as arsenic readily form direct compounds with the more basic metals, and these cannot readily be broken up. The degree of elimination of impurities depends therefore upon: (1) the amount of impurity present; (2) its affinity for oxygen; (3) its affinity for copper, and (4) the extent to which scorification is pushed.

Scorification consists of using an element as an oxygen carrier. In this case the principal scorifying agent is copper in the form of cuprous oxide. The process is to oxidize with an air blast some of the impurities directly and a part of the copper by air. The cuprous oxide formed dissolves in the bath and penetrates to all parts of it, reacting with elements which have a greater affinity than copper for oxygen and reducing out an equivalent amount of copper. These basic oxides further react with any acid material, such as silica in the furnace walls, that may be present and the resulting slag is skimmed off, leaving a purified bath holding a considerable quantity of cuprous oxide in solution.

The reducing stage necessary to throw back the cuprous oxide is now accomplished by generating a hydrocarbon gas by the destructive distillation of hard wood poles thrust beneath the surface of the bath, which is covered by a blanket of carbonaceous material to protect it from any further oxidation. The various steps will now be taken up in detail in the order in which they occur.

CHARGING

A reverberatory furnace is used for this work operated on a twenty-four-hour cycle. Starting with an empty furnace the first operation is charging. In the early days this was accomplished by hand, one pig or cathode being charged at a time. Two men would lift a pig to the end of a peel held in position at a charging door by a third man. This peel was a long heavy steel bar flattened like a paddle at one end. The three men would then thrust the peel into the furnace and flip the pig off at the desired location.

Various mechanical devices were tried to improve this practice, but for a long time the only successful innovation was the use of air lifts and tongs in placing the pigs on the peel. As furnaces gradually increased in size the time required to charge them became inordinate, and not only was the twenty-four-hour cycle badly disarranged, but the furnace cooled off badly during the delay. These difficulties led to trials of charging cranes developed in the open-hearth steel industry, but they were at first unsuccessful, due to a lack of fundamental differences between the two problems. The open-hearth furnace has a small charge simply thrown in it while the copper reverberatory by the old practice was piled with pigs clear to the roof. The first result of mechanical charging was an enormous loss in cold capacity which more than offset the other advantages gained. This failure checked further development along these lines for some time until a special form of peel consisting of a fork with a special pushing device (Prosser & Ladd, U. S. Patent) was devised to replace the upsetting shovel of the old type. This crane met with immediate success, and it was found possible to charge 5000 lb. at a time at a

rate of at least 200,000 lb. an hour and lose nothing in cold capacity as compared with the hand method, while at the same time charging a 200-ton furnace as quickly as the old 50 and 75-ton units had formerly been handled.

The main thing in charging is to have material which will stack well. This means that pigs should have a good blister finish and not be overblown and that cathodes should be reasonably smooth. When this is not the case individual charges after piling in the furnace will spill and take up much more space.

The next development along this line was the use of the crane for recharging after melting the first batch. In this way a certain molten tonnage in excess of the normal cold capacity of the furnace can be obtained.

Then it was found that anode scrap could be recharged to a certain extent while the metal was being poured. Finally cathodes were successfully charged while the refined copper was being poured (Addicks and Marks U. S. Patent No. 980,584). This will be referred to again later on.

In this way the limit to size has been practically eliminated as mechanical charging will rapidly take care of any sizes of furnace which can be built and the cost has been brought down greatly as the hand method exposed the crew to very severe heat.

MELTING

The next step in refining is the melting of the charge. This consists merely of burning as much fuel as the furnace can take care of. Copper is a good conductor of heat and the piled-up charge through which the hot gases have to filter absorb heat very rapidly. The melting is divided into three stages: (1) "softening," when the hot mass collapses; (2) "coming flat," when the molten metal covers the softened mass; and (3) "coming afloat," when the balance remaining on the bottom is absorbed.

It has been found that a semi-bituminous coal running about 20 per cent in volatile matter gives a desirable length of flame for this work. It is most essential that the coal should not form a fusible ash as deep fires are carried, and unless they are free burning a great deal of delay is encountered. In a refining furnace the old practice has been to fire heavily during the early stages of the refining and carry a bed of coke for heat during the later part so as to avoid sulphur from the fuel reaching the copper. With the present large charges, and particularly when recharging, while pouring it has been found necessary to fire more steadily and without any apparent untoward effect.

FLAPPING

When the charge is afloat a button is taken in a "say ladle," and if this throws a "worm," indicative of sulphur, a pole is introduced to agitate the bath, which is exposed to the air until a button sample shows a surface which is unbroken on cooling. This practice has a bearing on "overpoled" charges of refined copper to be taken up later.

The system of using buttons for samples is very old, but still stands as the best method of controlling furnace refining. A small ladle with a cup about an inch and a half in diameter is warmed by holding over the bath for a moment, then used as a rabble to sweep a clean face at the spot where the sample is to be taken

and then plunged beneath the surface and quickly withdrawn. The sample thus obtained is allowed to "set," when it may be dumped into water to cool for handling. Both the surface and the fracture upon nicking with a chisel and breaking in a vise give clear indications as to the state of the bath of copper. When sulphur is present a small volcano forms on cooling, which throws out a part of the metal which twists around as it chills much like a worm. When excess oxygen is present the surface shows a deep depression, and when the bath is nearly saturated with cuprous oxide this depression will break inward into a cavity. Copper at desired "pitch" for pouring will show a full rounding slightly wrinkled surface. Overpoled copper begins to "spew" and show the above-mentioned sulphur indications.

In the same way the condition of affairs may be noted by the color and structure of the fracture. When copper is saturated with cuprous oxide (about 6 per cent Cu_2O , beyond which point further oxidation will only cause useless slagging) the fracture shows a marked cubical structure, brick-red in color. As the oxygen is poled out the structure becomes more fibrous and the color brighter until we reach the lustrous silky texture corresponding to properly refined copper.

These simple tests enable a practiced eye to follow the refining operations with very satisfactory accuracy, and consequently metallographic and other methods have not come into use to any extent.

When the sulphur has been poled out the flapping or blowing begins. Originally a rabble was swung from a chain at the furnace door and the surface of the metal flapped or broken into spray by swinging this back and forth with free admission of air at all doors. This is hot and fatiguing work, and as the size of furnace charges increased it again became necessary to find some mechanical substitute. This was accomplished by blowing compressed air beneath the surface of the bath, sending up a fountain of molten metal instead of a mere splash and at the same time thoroughly stirring the bath itself. The great objection to this procedure has from the beginning been the consequent damage to the furnace structure. The fountain is so violent that more or less of the spray reaches the roof of the furnace and the metal highly charged with cuprous oxide avidly attacks the silica brick wherever it touches it. The large modern furnaces tend toward excessive repair costs as one of their disadvantages, and this corrosive action aggravates a situation already bad. When basic or neutral material such as chrome brick is substituted for acid brick construction, this trouble disappears; otherwise constant attention must be given to restraining the men in control of the air blast who naturally tend to over-vigorous application in order to gain time. Another remedy would be the use of low pressure air, which would not give such violent agitation, but the standard 80 lb. per square inch general service air system around the plant is generally utilized.

Chemically the method is very efficacious and the largest bath can be thoroughly saturated with cuprous oxide in a couple of hours at small expense. The iron pipe used gradually dissolves, but the amount of iron thus absorbed by the copper is proportionately so small as to be of no consequence even in a cathode melting furnace.

SKIMMING

The next operation is the removal of the slag, which is simply pulled off with a rabble through the skimming door into suitable pots. The skulls are later broken up and if the slag made was reasonably fluid, the large amount of metallics always present can be easily sorted out and returned to the furnace. Often slag rich in metallics is returned to the next charge.

The general question of slag formation requires consideration at length and will be taken up later on.

COKING

When the bath has been skimmed to a clean face, charcoal, coke or anthracite coal is spread over the surface to protect it from oxidizing influences during the subsequent poling operation. At first charcoal was exclusively used, particularly when melting cathodes on account of its low ash and freedom from sulphur. Then the much cheaper low-sulphur coke crushed to suitable size was substituted, reserving charcoal merely for the covering on the pouring ladle between the furnace and the casting machine, where the finishing touches are always put in adjusting the oxygen content of the product. Finally buckwheat coal has been largely used on anode charges as the cheapest form of carbon for such work.

As this blanket of floating fuel burns away it has to be renewed so that no bare surface be exposed to possible oxidation.

POLING

As regards poling, as the reduction of the excess cuprous oxide is called, little or no change has been made from early practice. As the furnaces have increased in size larger and longer poles have been used, but the method of forcing one end of a pole below the surface of the bath by using a chain tackle making an inverted lever against an iron cross bar is still in use. As the pole is consumed it is gradually fed in and a new grip taken with the chain until the stick becomes too short, when it is thrown into the furnace as a floating brand. Green hard wood gives the best results.

The poling operation is a very clumsy one. The poles are hard to handle and bulky to store. When a single charge takes twenty-five young trees to pole it up it may readily be seen that the surrounding country will soon be stripped of suitable timber and that transportation charges make the poling cost an ever-increasing burden.

Oil poling has been tried with but partially satisfactory results. The reduction is very rapid when fuel oil is blown beneath the surface of molten copper, a few minutes' time corresponding to two hours' ordinary poling. In fact, its very rapidity of action is one of the objections to its use, as it is difficult to arrest the reducing action before the copper is "overpoled." Another serious difficulty attendant on the use of oil when poling cathode charges is that the copper absorbs sulphur or other impurities from the oil, which give a very curious appearance to its surface on cooling, and would doubtless make its sale difficult even if no objectionable property were imparted to it.

Finally oil poling is very variable in its expense. Apparently it is very easy to use twice the amount to

pole one charge that is necessary for another, the excess oil being burned above the surface of the charge.

These difficulties have prevented the general use of direct oil poling. Nevertheless it seems probable that the time will come when gas poling will be used. It is evident that an outside source of heat can be used for the destructive distillation of wood or that oil or coal gas could be made suitable for the purpose. In the case of wood the cheapest available form of waste could be utilized instead of valuable young trees. Such a gas could be readily controlled in its action and a gas made from wood waste would require no purification.

As the poling operation proceeds sample buttons are frequently taken for examination, and when the desired amount of reduction as shown by these tests is nearly attained an ingot is poured and the nature of the "set" surface on the top of this casting inspected. When a full rounding surface is obtained the charge is ready to pour. Castings of different sizes require a different amount of unreduced oxide in order to obtain a level surface in an open mold. The final adjustment is therefore made in the casting ladle, where charcoal is added or allowed to burn thin according to the appearance of the set on the castings being made.

Should poling inadvertently be allowed to continue too long the charge becomes "overpoled," a condition the symptoms of which are much better understood than the underlying causes. The surface of a casting made from such copper swells as it cools until it breaks or "spews," giving a "worm" similar to that noted in connection with sulphur-bearing anode charges. While such a condition can be apparently rectified by a slight oxidation of the charge, copper in this state becomes unmanageable as regards its set, and such rapid vacillations are encountered while pouring that accepted practice is to flap the charge down again to "dry" copper and pole back to the proper oxygen content, or, in short, to re-refine the entire charge. The unstable condition can be controlled by adding certain substances, notably lead, in small quantities, but as mere traces of lead make copper brittle the cure is worse than the disease. It is probable that sulphur plays some part in this peculiar behavior.

POURING

Furnaces up to 20 tons in capacity used to be ladled by hand, a group of five or six men each with a ladle holding some 15 or 20 lb. of copper forming an endless chain between the "ladle hole" and the molds. The latter were made of cast iron or copper placed over a shallow bosh and the castings were dumped by hand into the water from which they were fished with suitable tongs. The next development was the "bull ladle," which is still in use at some places. This was simply a large ladle slung from an overhead crawl, enabling one man to dip out as much at a time as the five or six had done before.

Then came the casting machines, which have developed along several lines. Three general types are in use—the endless chain conveyor first developed by McCoy, the well-known Walker wheel and the variation of this known as the Clark machine.

The first, which has now gone out of use for wire bars, but is still occasionally employed for anodes and more recently in casting blister copper into pig, carried the molds on a link belt mechanism in front of the

spout, then lowered them on inclined rails into a bosh of water and then dumped the castings as the molds returned upside down on the return trip underneath the bosh. The Walker wheel, as its name implies, has a central hub carrying the rotating mechanism and radial arms supporting the molds. The Clark machine differs from the Walker chiefly in that the molds are carried parallel to the radial arms while on the latter they are placed circumferentially, and still further modifications have been made at the new Great Falls plant.

The Walker scheme has two advantages over each of the other types due to the way the molds are placed when casting wire bars. When the length of the mold is in line with the stream of copper there is a decided wash, which tends to make "splashes" and "cold sets" in the finished bar. Then in order to bring successive molds in line it is necessary to start and stop the machine, which jars the partially set castings just made and tends to make "edges," while the Walker wheel runs continuously, the pouring being done on the fly, so to speak. The lost motion and jarring of the link-belt type of machine was the chief reason for its abandonment in addition to higher maintenance costs. The Clark machine has the advantage that it will accommodate the giant wire bars supplied to a certain extent to foreign wire mills.

As the size of furnace began to outstrip even mechanical means for casting, always having in mind the desirability of completing a furnace cycle in an even twenty-four hours, the multiple-lip ladle was devised. In this way as many as four wire bars or eighteen ingots are poured at one movement of the intercepting ladle. Then came the twin ladle, and it was demonstrated that casting could be conducted at the rate of over 100,000 lb. an hour. This could again be doubled by using two wheels.

The bars are carefully inspected before shipment and any minor defects such as small "fins" cut off with a hammer and chisel. The temperature of the bosh water and also of the molds has much to do with the appearance of the finished product, although color due to slight films of oxide has not the importance attached to it to-day that was formerly the case. The bars should be dropped into the water as soon as possible after solidification is complete. The molds, which upset but do not enter the water and are sprayed to cool them, should retain a temperature just sufficient to enable them to thoroughly dry and properly take the bone ash wash which is applied to prevent the bars from sticking. On the other hand, the temperature of the bosh water itself must be held down by a circulating system to a point where it does not interfere with clear vision due to clouds of steam given off.

Various materials have been tried out as substitutes for the rather expensive bone ash used in painting molds. It is necessary that the substance used should have a high melting point, have no tendency to enter into chemical combination with molten copper, and particularly give off no gaseous constituent under heat which would tend to make the casting porous.

Lampblack serves the purpose, but is not readily applied. A smoked mold gives a beautiful casting. Pulverized silica is another substitute, but as the finish given is not entirely satisfactory its use is confined to anode work.

Bone ash should be thoroughly calcined to be free from grease, which evolves gases in the mold. A typical analysis of bone ash is:

$\text{Ca}_3\text{P}_2\text{O}_8$	97.69 per cent
Li_2O_2	1.01 per cent
MgO	1.02 per cent
Total	99.72 per cent

Many of the minor physical defects in refined copper can be traced to improper mold wash.

Another matter which needs attention is the chemical composition of the water used for cooling the copper. It is quite possible by constant evaporation coupled with an impure make-up water to obtain concentrations of sodium chloride and other salts which will crystallize out on the surface of the hot molds in sufficient quantity to cause pinholes in the bars.

The molds themselves can be made of either iron or copper, but the latter gives the best results. For many years molds were made by filling a built-up iron box with molten copper into which was thrust a core imprinting the desired shape. This method involves a complicated calculation of shrinkages starting with an iron mother core to produce a copper mother mold, which in turn makes copper cores from which the final molds are obtained. To-day this has been largely superseded by molding in sand with an ordinary wooden pattern.

A mold generally fails by burning or by warping. Spongy spots can be hammered up, but a mold should be discarded before any appreciable sponginess is found in the castings produced. Cracks in a mold tend to hold water which steams while the copper is being poured.

The general question of defects in refined copper and their causes will be discussed more in detail in a future article.

THE FURNACE CYCLE

A normal cycle for a large modern furnace would be about as follows:

Charging	3 hours
Melting to "flatness"	5 hours
Recharging	1 hour
Melting to "afloat"	5 hours
Blowing	2 hours
Skimming	1 hour
Polling	2 hours
Pouring	5 hours
	24 hours

The fire is grated and rebuilt during the charging period.

SLAG FORMATION

The amount of slag made naturally varies with the nature of the charge. It is a minimum when melting straight cathodes. The addition of wire mill scrap at once increases it. In the anode furnace we have in addition to blister copper, black copper, silver building slag, liberator tank residues, cement copper, secondary scrap copper and miscellaneous clean-up material.

It is possible to melt cathodes in a basic furnace and keep the slag made down to a small fraction of 1 per cent of the weight of the charge. In order to do this care must be taken to keep clay used for luting up the furnace doors from getting into the bath and the fire must be so managed as to blow as little coal ash over as possible as it increases slag by uniting with copper oxide.

On the other hand, a foul anode charge may make 20 per cent of slag and still represent good work. Representative slag assays are given in Table I.

TABLE I—REFINING FURNACE SLAG ASSAYS

Per Cent	Copper	Iron	Nickel	Insoluble	Lime	Sulphur	Arsenic
Anode slag...	40.51	5.30	6.99	38.74	0.25	0.17	0.21
Wirebar slag...	48.55	2.99	...	41.73	0.53	0.19	...

When nickel is present in quantity an infusible scoria is formed which carries with it a mass of metallics. Tin likewise forms a blanket of stannic oxide, which, however, can be fluxed.

Although the elimination of the elements occurs in the order of their oxidizability the separations are not sharp, and while a certain classification of impurities for further treatment can be roughly made, the losses in any such plan to separate lead, tin, zinc, etc., must necessarily be large, due to overlapping.

In the same way the copper slagged off carries with it some gold and silver. When anode assays over a period of time are compared with corresponding anode slag assays the silver appears too high. This is due to the large amount of silver brought into the charge in silver-building slags, which is not efficiently collected in the anodes but is passed on to the anode slag retreatment stage before it is again associated with the copper. Table II gives some assays where true comparisons can be made for both anode and wire bar furnaces.

TABLE II—RELATIVE SLAGGING OF GOLD AND SILVER

	Per Cent Copper	Oz. per Ton Silver	Oz. per Ton Gold
Anode slag	32.50	14.3	0.27
Anodes	99.44	81.48	2.299
Compensated slag assay	99.44	43.75	0.826
Slagging ratio	1.000	0.537	0.359
Wirebar slag	48.55	1.35	0.0140
Wirebars	99.94	1.40	0.0104
Compensated slag assay	99.94	2.76	0.0286
Slagging ratio	1.000	1.97	2.75

The surprising difference in the behavior of the wire bar furnace is due to the fact that the silver and gold in the cathodes is not alloyed with the copper but mechanically entangled as wandering anode slimes. Upon fusion some of this slime floats and is skimmed off with the slag. It is not all released, however, as we see not only by direct assay of the wire bars but from the lowering of electrical conductivity by one or two per cent when wire bars are compared with cathodes.

The general question of making anodes from foul material will be reserved for treatment in a separate article.

THERMAL EFFICIENCY OF THE REFINING FURNACE

The coal consumption of a large modern refining furnace under average operating conditions is about 12 per cent of the good product made. As the coal used in obtaining this figure runs about 13,750 B. T. U. per pound the heat requirement is 13,750 x 0.12 or 1650 B. T. U. per pound of copper produced.

If we take the mean specific heat of copper at 0.11 and the latent heat of fusion as 80 B. T. U. per lb. and assume that copper is charged at 70 deg. F. and poured at 2170 deg. F. we have the net heat input required 0.11 x 2100 + 80 or 311 B. T. U. per lb., giving an efficiency of 311 ÷ 1650 or about 19 per cent. Waste heat boilers now recover heat equivalent to at least 6 lbs. water from and at 212 deg. F. per lb. coal burned in the furnace. This is equivalent to 966 x 6 x 0.12 or 696

B. T. U. per lb. of copper, bringing the overall thermal efficiency up to 1007 ÷ 1650 or about 61 per cent.

It will therefore be seen that operating as a simple reverberatory the furnace is very wasteful but that when there is a demand for steam the combined furnace and boiler is nearly as economical of heat as would be an electric furnace. The general question of waste heat boilers will be dealt with in a later article.

RETREATMENT OF SLAGS

Slags made from normal anode and refining furnace charges require reduction with the substitution of another base to free the copper. As the slags from cathode charges carry very small values in gold and silver they are sometimes kept separate from the anode slags and the copper recovered therefrom made into casting copper in order to avoid the cost of passing this metal through the anode furnace and tank house steps of the process.

The simplest means of reduction is a small blast furnace operated with limestone and pyrites cinder as fluxes and making black copper as a product. A furnace much smaller than 44 in. x 66 in. gives trouble in keeping the crucible open and as even this small size has a capacity in excess of the requirements of most refineries, it is often necessary to run intermittent campaigns.

If true black copper is made—say 97 per cent copper carrying considerable iron—a very bad slag is inevitable, the copper running 2 or 3 per cent therein. As a rule there is enough sulphur in the iron flux used to produce a little matte, and a copper running about 94 per cent and a slag of 0.6 per cent is made. This product delays the work in the anode furnace unless it is systematically charged back day by day, as small quantities of sulphur take some time to blow out of an anode charge.

Where a smelter is operated in conjunction with a refinery, these furnace slags are usually added to the ore charge. The reducing action in a matting furnace is hardly strong enough to thoroughly decompose these high grade silicates and a noticeable increase in oxidized slag losses always follows their addition to the charge.

They are also very difficult to accurately sample on account of the metallics contained and the refinery will suffer and the smelter correspondingly gain unless special supervision is exercised over this sampling, as the workmen naturally avoid metallics in taking the sample as they give such trouble in the crushing.

Finally nothing is gained in cost by matting these slags, as the advantage of the larger scale of operation and somewhat lower slag losses is offset by the sampling costs and complication of adding sulphur to this high grade sulphur-free material only to blow it out again in the succeeding converting operation. The anode furnace gains somewhat however in not having any low grade black copper to treat.

FUTURE DEVELOPMENTS

Great progress has been made in the development of the refining furnace and not much remains to be done along purely structural and mechanical lines. In twenty years the 24-hour charge capacity has been changed from 20 tons to 250 tons and furnaces of greater capacity could easily be built were there any

justification for it. The copper is handled mechanically both in and out of the furnace. The hearth is now constructed of magnesite brick when a corrosive charge is to be handled. The walls and verb and sometimes the entire roof are now built of chrome brick to withstand the copper oxide wash.

In firing the furnace there is yet some room for progress, but when it is considered that an open hearth steel furnace takes four times as much fuel per ton of product, it will be seen that there is not the same justification for expensive gas firing equipment. Either oil or gas firing may be successfully applied, however, and commercial factors may some day call for their introduction. The poling operation as already pointed out will doubtless in time be replaced by gas reduction.

Metallurgically the anode operation is quite satisfactory. The melting of cathodes is not in such good shape, however, as here what should be a simple melting is expanded into a complete refining. This has been attacked in two ways—by the use of the electric furnace and by continuous melting.

The electric furnace is not very promising as it has already been shown that with a waste heat boiler attached the heat efficiency of the reverberatory is high enough to give electric heat from steam driven generators a hopeless handicap. Then the high electrical conductivity of copper, the shape of the cathodes to be melted and the necessity of having the product absolutely free from bits of charcoal or other resistor material, introduce limitations in the design of the furnace.

It must also be remembered that there is a slight refining done in melting cathodes as shown by the concentration of impurities in the slag as well as the effective elimination of sulphur brought in as entrained sulphates from the electrolyte.

Continuous melting is more attractive. The method already described of charging large quantities of cathodes during pouring and carefully excluding all acid material from contact with the bath to avoid the formation of slag has been for some years in successful use and might be called semi-continuous melting. It is obvious that the principle could be extended until the amount charged just balanced the amount poured, but this requires slow casting rates in order to keep the heat up and introduces some practical difficulties. The sulphur is controlled in this method by inserting piles of cathodes which do not fully submerge in the molten bath. This gives the opportunity for a little oxidation of the exposed sheets before the mass softens and becomes immersed.

Various patents have been issued for plans which virtually combine a blast furnace melting with a reverberatory fore-hearth. Copper is so readily contaminated by contact with products of combustion, etc., however that it is difficult to apply methods of direct melting without having to go through a large part of the regular furnace treatment afterwards.

Perhaps the weakest point in the present reverberatory practice lies in the system of utilizing labor. Custom has placed a crew in charge of each furnace. Originally a night crew did the melting and rabbling and some of the poling while the day crew would attend to the ladling and charging. As a number of men were required for hand ladling this fitted in with the heavy work of charging. All the furnaces were supposed to be

ready to cast early in the morning and the crew kept hours depending upon the furnace which would generally get progressive—later during the week, the over Sunday period being used to catch up.

When mechanical ladling was introduced it became necessary to organize special labor gangs to assist in the charging of the furnaces which now were much larger and with a reduced ladling crew.

Mechanical charging, however, eliminated this trouble and the necessary crew for handling a furnace is very small. The old system is therefore beginning to give way to one where instead of operating in unison the furnaces are intentionally staggered. In this way they may be skimmed one after another, for example, and a casting crew can be organized who will go from one furnace to another and be replaced by a new shift at a predetermined hour, making the men entirely independent of the behavior of individual furnaces. When this is fully accomplished furnace work will become a less arduous and less specialized occupation.

Recovery of Sulphur from Illinois Coals

By Joseph E. Pogue

Illinois coals contain from 1 to 6 per cent of sulphur. This is present chiefly in the form of a brass-yellow metallic mineral, known technically as pyrite or marcasite, but called commercially "coal-brasses" and termed by the miners "sulphur." This material occurs as small seams, lenses, and nodules scattered through the coal, and is generally looked upon as an objectionable impurity, because it must be removed before the coal is marketed. As a matter of fact, however, this so-called impurity is a raw material of value for the manufacture of sulphuric acid, and its worth at present is from three to four times as great as that of the coal itself. Its recovery, therefore, in those mines in which it is now thrown aside affords a good opportunity for turning a troublesome waste product into profit and thus establishing a new source of revenue with little added effort. Into such strong demand has pyrite come that there is even a possibility that some mines, abandoned because of the unusually high sulphur content of their coal, may be reopened and successfully operated as pyrite producers, with coal as the incidental or by-product.

A few of the Illinois coal mines for a number of years have been recovering their pyrite and selling it to nearby chemical works; but the output of the entire State for any given year has never exceeded 27,000 long tons, and the total value of the pyrite produced from 1907 to the present in round numbers amounts to only \$400,000. These figures fall far short of the possibilities of the State in this respect. With a coal production around 60,000,000 tons a year and pyrite worth upwards of \$8 a ton, the Illinois coal fields have the opportunity of greatly extending their pyrite yield and of building up a substantial by-product industry around this mineral.

The time is unusually favorable for doing this. Conditions growing out of the world war have created an unprecedented demand for pyrite. Before the war, the United States was producing about 3,500,000 tons of sulphuric acid per year, nearly two-thirds of which was made from pyrite imported from Spain. The extraordinary impetus given to chemical manufacture by the war

needs of the Allied Governments has succeeded in largely increasing our sulphuric acid requirements, while the submarine campaign has cut off a large share of the Spanish ore and endangered the meager supplies still being received from that source. The situation, therefore, is serious and even critical; for sulphuric acid is not only essential to the manufacture of explosives and fertilizers, but is required in practically every chemical industry, and in consequence underlies the whole fabric of our industrial life. An impaired sulphuric acid production would be fraught with the most serious industrial consequences. The pyrite situation reached its climax during the past few months, and a realization of the importance of this matter has created a lively activity on the part of both American industry and the Government to develop sufficient domestic raw materials to meet the current sulphuric acid needs before the pyrite reserves on hand become exhausted or the Spanish mines be completely barred.

There are four domestic sources of materials suitable for the manufacture of sulphuric acid. These must not only be looked to to tide over the present emergency, but they also have the opportunity of establishing under present circumstances an enlarged output which can replace part at least of the Spanish supply in the period succeeding the war. The first of these sources is included in the many small deposits of pyrite and related sulphides scattered through the Eastern States. These were formerly unable to compete with the Spanish ore, brought to this country cheaply as ballast by Mediterranean freighters; but now, enlivened by favorable prices, they are contributing an appreciable tonnage to acid plants. The second source is formed by the fumes of many smelters, chiefly in the Western States, formerly allowed to go to waste, but now turned into acid. This was the most important domestic source of sulphuric acid even before the war, and is now producing at an increased rate; but it is incapable of meeting the situation alone, not only because unable to produce a sufficient tonnage, but more especially because costly freight hauls wall off the eastern and mid-western manufacturing centers. The third source is the large deposits of native sulphur at Sulphur, Louisiana, and Bryan Heights, Texas, which produce a very pure product, too highly priced under normal conditions to compete with pyrite, but which may be drawn upon to meet the pyrite shortage during the present emergency. The final source is the pyrite or "coal-brasses," partly saved but largely wasted, in connection with bituminous coal mining, a source capable of considerable enlargement, particularly in Illinois where the pyrite content of the coal in many localities is sufficiently great to afford significant quantities of this valuable and desirable material.

The State Geological Survey desires to bring to the attention of the coal-mining interests of Illinois the urgency of the pyrite situation, with the hope that the pyrite possibilities of each mine will be given careful consideration. It is believed that if pyrite be recovered from all mines in Illinois in which it may be produced at a profit, the output of the State will be raised to a significant figure, a paying side-industry will become permanently attached to the mining of coal, and much-needed assistance will be rendered the United States in the present military emergency.

To those operators who are interested in the com-

mercial possibilities of pyrite recovery, reference may be made to a publication by E. A. Holbrook, issued by the Engineering Experiment Station of the University of Illinois, dated August 20, 1917, and entitled, "The Utilization of Pyrite Occurring in Illinois Bituminous Coal," copies of which may be obtained by addressing the State Geological Survey, Urbana. This paper gives detailed specifications, based on careful experimental tests, for a simple mill, which may be installed at an approximate cost of \$18,000, capable of producing from hand-picked material 50 tons of commercial pyrite per 8-hour day, at a profit of \$1.50 a ton.

The State Geological Survey is seeking to bring the matter to a head at the earliest possible moment and is therefore sending a representative to the principal coal districts in which pyrite is known to occur in significant quantity. He will be prepared to furnish a list of the available markets and the requirements which the material must meet to be accepted for acid manufacture; to discuss the general industrial situation in regard to pyrite, with special reference to the opportunities for continued development after the war; to furnish specifications of mill installation for handling the product; to gather data for estimating the total pyrite possibilities of the State; and in general to render such assistance toward stimulating production as lies within the power of the State Geological Survey.

The need is urgent for an increased pyrite production in the United States. The opportunity is present for enlarging the output in Illinois. A response to the present situation will result not only in profit to the coal mining industry of the State, but will constitute an important contribution toward solving one of the most critical resource problems faced by the nation today.

But the issue is even more far-reaching than that involved in the opportunity of profit or even of patriotic service. It is becoming more and more evident that the best interests of any industry lie along the line of co-ordinated development, not only of all possibilities within itself, but of all points of contact with other industrial activities as well. Industrial aloofness is becoming as impossible of economic justification as is national isolation. The establishment on a firm basis of a by-product development in connection with coal mining assumes in this light, an importance out of proportion to its measure in tonnage or value involved. To add a new facet to the Illinois black diamond may not complete its brilliance, but it will augment its luster.

State Geological Survey,
Urbana, Illinois.

Chicago Companies Foregoing Holiday Cards

A number of companies in Chicago, including the large steel companies, have this year decided not to distribute holiday greeting cards but to give the money formerly spent for this purpose to war-relief organizations such as the American Red Cross, American Fund for French Wounded, etc. Among the companies which are doing this are the following: Illinois Steel Company, Morden Frog & Crossing Company, American Steel & Wire Company, Universal Portland Cement Company, Lackawanna Steel Company, Carnegie Steel Company, Inland Steel Company, Chicago Railway Equipment Company, A. M. Castle & Company, The P. & M. Company, A. J. O'Leary & Son Company.

Laboratory Methods for Benzol-Recovery Plant Operation—II

By F. W. Sperr, Jr.

Chief Chemist, H. Koppers Co.

(Continued from Page 555)

Method for the Boiling Point Tests of Benzols

An interesting article could be written descriptive of the evolution and standardization of the boiling point test which is in universal use by all makers and users of the various benzols. It is not, however, our purpose to do this, but we shall simply give the details of the method that we are employing at present, in the belief that some of these details—which have hitherto been omitted in the descriptions of this method published in various American books and journals—may be found in convenient form to include in standard specifications.

The European method—which is referred to two or three times in our description—may be found in Lunge's "Coal Tar and Ammonia," fourth American Edition, p. 755. The American method was described about six years ago by S. R. Church (*Jour. Ind. Eng. Chem.*, 1911, p. 227, V. Drawing No. 8, p. 232). A number of modifications have since been more or less widely adopted, such as the substitution of the standard Engler flask for the 200 cc. Jena flask, and it is probable that the most up-to-date description of the method is that given in the Gas Chemists Handbook, recently published by the American Gas Institute (p. 180). It is stated that the method in the Handbook is adapted with some modification from the report of Sub-Committee D-1 A. S. T. M., 1915. In the notes appended to our description, reference will be made both to the A. G. I. and the A. S. T. M. committee report.*

After experience with both the European and the American methods, there can be no hesitation in affirming that the latter is superior, but it still suffers the fault that many of its essential details have not been standardized with sufficient precision.

FLASK

The flask used shall be the standard Engler flask, as described in various standard works upon petroleum such as Redwood, Hole, etc. The flask is of globular shape 6.5 cm. in diameter, with a cylindrical neck 1.6 cm. in internal diameter, and 15 cm. in length. Half way up the side of the neck a vapor tube of not less than 5 mm. diameter and not less than 10 cm. nor more than 12 cm. in length extends at an angle of 75 deg. downward to the condenser. The junction of the vapor tube with the neck of the flask is 9 cm. above the surface of the oil when the flask contains its charge of 100 cc. of oil.

Notes: Redwood's description, as quoted by the A. G. I. and the A. S. T. M., omits the position and diameter of the vapor tube, both of which are important. With a vapor tube too long or too constricted in diameter, a pressure is produced within the flask during distillation, which has a material effect on the boiling point.

CONDENSER

The condenser tube, see Fig. 5, shall consist of a straight piece of thin glass 24 in. in length, having an

inside diameter of $\frac{1}{2}$ in. throughout. There shall be no constrictions or irregularities in the condenser tube. The tube shall be fitted with a 15-in. jacket having connections for cold water. The tubulature of the distilling flask shall be inserted through a tightly fitting cork 2 in. into the condenser tube.

Notes: A. G. I. specifies tube of thin glass 24 in. in length. Does not specify diameter of tube nor length of jacket. One form of condenser is objectionable because the enlarged adapter holds a small amount of benzene and cannot be thoroughly drained in the position shown. The side neck of the distilling flask should project some little distance beyond the cork instead of being flush with the cork. The A. S. T. M. condenser is of the trough type 15 in. long, having a tube of thin brass $\frac{1}{2}$ in. internal diameter by 22 in. long. The lower end of the condenser is cut off at an acute angle and is curved down for a length of 3 in., so as to project at least $\frac{1}{2}$ in. into the 100-cc. cylinder used as a receiver. A pasteboard cover should be placed over the top of the cylinder and surrounding the condenser tube. The choice between the trough and the ordinary Liebig condenser jacket is simply a matter of personal preference. The same is true of the choice between glass and brass for the condenser tube. In using the trough, arrangements should be made for continuous circulation of water. In benzol work it is not necessary to have the end of the tube curved, as recommended by the A. S. T. M., and the straight tube considerably facilitates cleaning.

BURNER

A standard Bunsen burner having separate adjustments for regulating the supply of gas and air shall be used. The opening at the top of the burner shall be 5/16-in. diameter. When making distillations the flame of the burner must be so regulated as to be blue at any portion of the top.

Notes: A. G. I. and A. S. T. M. give no specifications. The burner recommended is the one most commonly used in this work. The specification regarding the character of the flame is borrowed from European specifications, and is good practice, since a smoky flame may give unsatisfactory results.

FURNACE

The flask sits on an asbestos slab $\frac{1}{8}$ in. thick and 6 in. square, having a circular hole 1 in. in diameter in its center. The furnace is cylindrical in shape, 5 in. in diameter and 8 in. tall. It has four round holes—1 in. in diameter—equally spaced around the top, 10

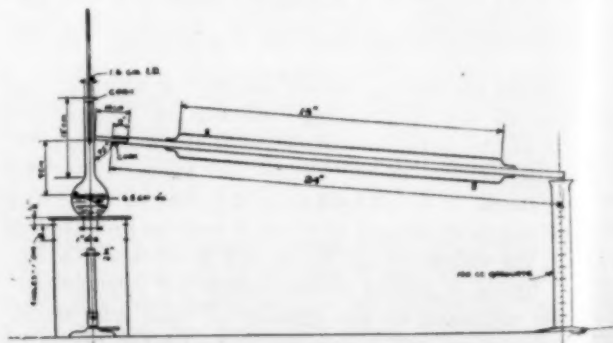


FIG. 5. CONDENSER ARRANGED WITH FLASK AND RECEIVER

*See also the recently published Standard Method for Testing Paint Thinners other than Turpentine—A. S. T. M. standards adopted in 1917, p. 7.

cated $\frac{1}{2}$ in. below the top, for the escape of products of combustion.

Notes: A. G. I. specifies a $1\frac{1}{2}$ -in. opening in the asbestos. A. S. T. M. specifies a $1\frac{1}{4}$ -in. opening. The Barrett Company's laboratories have found a 1-in. opening much more satisfactory, and our own tests confirm this. The following comparisons may be of interest:

Using a $1\frac{1}{2}$ -in. opening in the asbestos flame guard.

	Jena Flask	Engler Flask
First drop	79.72	79.65
5%	80.12	80.15
10%	80.22	80.25
20%	80.32	80.27
30%	80.32	80.30
40%	80.32	80.33
50%	80.32	80.35
60%	80.32	80.35
70%	80.33	80.35
80%	80.37	80.35
90%	80.42	80.45
Dry	81.02	81.25

Using a 1 inch opening in the asbestos flame guard.

	Jena Flask	Engler Flask
First drop	79.87	80.01
5%	80.22	80.33
10%	80.34	80.35
20%	80.36	80.36
30%	80.36	80.36
40%	80.36	80.36
50%	80.36	80.36
60%	80.36	80.36
70%	80.36	80.36
80%	80.37	80.36
90%	80.38	80.37
Dry	80.41	80.44

It can readily be seen from the above figures that the 1-in. opening is the better size for the following reasons:

1. With a 1-in. opening it is difficult to drive over the first drop too rapidly, and different operators will not vary greatly.

2. It is almost impossible to run the distillation too fast.

3. With only a 1-in. opening the dry point is much easier obtained, as the tendency to superheat is greatly reduced.

The shield recommended by the A. G. I. Handbook is unsatisfactory because it would be almost impossible to determine the "dry point" satisfactorily.

The one recommended by A. S. T. M. is rather cumbersome.

The shield above recommended is copied after European practice and has always given very good results.

RECEIVER

An ordinary 100-cc. graduate (graduated in 1 cc.) is used for the receiver. Graduations must be clear cut and distinct. The graduate should be approximately 1 in. in diameter. The mark for each 10 cc. should be longer than the intermediate markings and should be plainly numbered.

Notes: This is essentially the same as specified by the A. G. I. and the A. S. T. M., but the specifications have been made more definite.

THERMOMETER

All distillation thermometers shall be made of resistance glass of a quality equivalent to suitable grades of Jena or Corning makes. They shall be thoroughly annealed. They shall be filled above the mercury with inert gas which will not act chemically on nor contaminate the mercury. The pressure of the gas shall be sufficient to prevent separation of the mercury col-

umn at all temperatures of the scale. There shall be a reservoir above the final graduation large enough so that the pressure will not become excessive at the highest temperatures. The thermometer shall be finished at the top with a small glass ring or button suitable for attaching a tag. Each thermometer shall have—for identification—the maker's name and a serial number.

For the boiling determination of crudes and solvent naphthas the thermometer shall be graduated from 0 deg. to 400 deg. C. at intervals of degrees Centigrade. Every fifth graduation shall be longer than the intermediate ones, and every tenth graduation beginning at zero shall be numbered. The graduation marks and numbers shall conform to the following dimensions:

Total length, mm.	385 maximum
Diameter of stem, mm.	7, tolerance 0.5
Diameter of bulb, mm.	5 minimum and shall not exceed that of stem
Length of bulb, mm.	12.5, tolerance 2.5
Distance 0 deg. to bottom of bulb, mm.	30, tolerance 5
Distance, 0 deg.-400 deg.	295, tolerance 10

The accuracy of the thermometer when delivered to the purchaser shall be such that when tested at full immersion the maximum error from 0 deg. to 200 deg. C. shall not exceed 0.5 deg.; 200 deg.-300 deg. C., it shall not exceed 1 deg. C.; 300 deg.-375 deg. C., it shall not exceed 1.5 deg. C. The sensitiveness of the thermometer shall be such that when taken at a temperature of 26 deg. C. and plunged into a free flow of steam the meniscus shall pass the 90 deg. C. mark in not more than 6 seconds.

For the boiling determination of pure benzene and pure toluene the thermometer shall be graduated from 70 deg. to 120 deg. C. at intervals of $1/10$ deg. C. Each graduation for half degrees shall be longer than the intermediate ones, and each degree beginning at 70 deg. C. shall be numbered. The graduation marks and numbers shall be clear cut and distinct. The thermometer shall conform to the following dimensions:

Total length, mm.	460 maximum
Diameter of stem, mm.	7, tolerance 0.5
Diameter of bulb, mm.	5 minimum, and shall not exceed that of stem
Length of bulb, mm.	12.5, tolerance 2.5
Distance 70 deg. C. to bottom of bulb, mm.	95, tolerance 5
Distance, 70 deg. C. to 120 deg. C., mm.	330, tolerance 10

The thermometer, when delivered to the purchaser, shall be furnished with a calibration sheet by the maker, with corrections at 80 deg. C. and 110 deg. C., together with the difference between the expansion of the mercury and glass used, for making correction for emergent stem. All thermometers shall be calibrated for total immersion.

Notes: The thermometer for the determination of crude materials is the same as specified by the A. G. I., and has some slight differences from the A. S. T. M. description. It is necessary in addition to this to have a very accurate thermometer for tests of pure benzols. We have found the thermometer described above to be very much more satisfactory than the one described on

p. 187 of the A. G. I. Handbook. Most specifications for pure benzene call for a range of 2 deg. A single interval on the scale of the A. G. I. thermometer amounts to 10 per cent of this range, and the graduations are so close that it is difficult to interpolate satisfactorily.

METHODS OF DISTILLATION

The flask, connected with the condenser, shall be filled with 100 cc. of the material at 15.5 deg. C., which shall be measured in the 100 cc. receiving cylinder. The same cylinder may be used without drying as the receiving vessel for the distillate. The thermometer shall be inserted through a tightly fitting cork in the neck of the flask so that the top of the thermometer button will be on a level with the bottom of the side outlet in the neck of the flask and in the center of the neck. The distillation shall proceed at a rate of not less than 4 nor more than 5 cc. per minute into the receiving cylinder. The flask must be heated very slowly just before the first drop comes over in order that the thermometer will register the correct temperature. The temperature at which the first drop leaves the end of the condenser shall be considered the initial boiling point. In testing pure benzols and refined naphthas, the distillation shall be continued until the last drop is vaporized, when a puff of white vapor usually appears in the bottom of the flask. The temperature at this point shall be considered the end or dry point of the distillation. The total yield of distillate shall not be less than 97 per cent.

Notes: In making tests of pure benzene, toluene, xylene and refined naphthas, it is our practice to record the following temperature readings: First drop, 5 per cent, 10 per cent, and each 10 per cent thereafter to the dry point. The intermediate readings may be omitted at discretion, but often serve a useful purpose in benzol plant operation. In tests of light oils, it is our practice to record the following readings: Temperature of the first drop and per cent distillate at the following temperatures: 80 deg. C., 95 deg. C., 100 deg. C., 120 deg. C., 150 deg. C., 180 deg. C., 200 deg. C. In case the dry point should come before any of the above temperatures are reached, this is recorded and the distillation discontinued. Doubtful products and residues are distilled in a 200-cc. glass flask similar to Fig. 3, p. 556, using a 100-cc. sample and a thermometer having a range between 70 and 400 deg. C. Temperatures are recorded for the following: 5 cc., 10 cc., 20 cc., 30 cc., 40 cc., 50 cc., 60 cc., 70 cc., 80 cc., 90 cc., 95 cc. In case of the still residues, the distillation is stopped when the oil becomes extremely thick and viscous. In making boiling-point tests of refined or pure benzols it is often important that corrections for emergent stem and barometric pressure be made. (In the case of crude materials this is not so essential.)

EMERGENT STEM CORRECTION

Let C = Number of degrees Centigrade to be added to the observed temperature.

N = Number of degrees of the stem exposed.

T = Average temperature of the bulb.

t = Average temperature of the stem.

K = Correction factor for the thermometer (i.e., the difference between the coefficients of expansion of mercury and glass).

Then: $C = KN(T - t)$.

For example:

Observed temperature = 80 deg. C.

Steam temperature = 25 deg. C.

Degrees emerging (from top flask to 80 deg. C.) = 15 deg. C.

Thermometer coefficient = 0.000154

80 deg. C. — 25 deg. C. = 55 deg. C.

15 deg. x 55 deg. x 0.000154 = 0.12787 = 0.13 deg. C.

Temperature corrected for emergent stem = 80.13 deg. C.

BAROMETRIC PRESSURE CORRECTION

The difference of temperature for each millimeter between 720 mm. and 780 mm. is in the case of:

Benzene 0.043

Toluene 0.047

Xylene 0.052

50 per cent Benzol..... 0.0461

90 per cent Benzol..... 0.0453

For example:

If barometer reading is 754.7 mm. (at 0 deg. C.) and thermometer (corrected for emergent stem) is 80.13 in the case of benzene:

760 — 754.7 = 5.3 mm.

0.043 x 5.3 = 0.2279 = .23 deg. C. to be added.

80.13 deg. + 0.23 deg. = 80.36 deg. C. corrected temperature.

Note: It must be borne in mind that if the barometer reads above 760 mm. the barometric correction must be subtracted.

Exports of American-Made Dyestuffs from the United States

The new classification used since the beginning of the current fiscal year by the Bureau of Foreign and Domestic Commerce in its monthly statements of domestic exports shows separately for the first time the item of aniline dyes. For the month of July the shipments of American-made aniline dyes from the United States to foreign countries amounted to \$497,106.

Of all the industries created or developed as a direct result of war conditions, none has shown more rapid progress than American dyestuffs. From only seven establishments, in which 528 people were engaged in producing 6,619,729 pounds of coal-tar colors, valued at \$1,126,699 in 1914, the industry has developed until now it not only supplies the domestic demand for colors, but also part of the foreign market.

Articles, and Countries to which Exported	JULY—		SEVEN MONTHS ENDING JULY—		
	1916	1917	1916	1917	1917
Dyes and dyestuffs.....	\$687,555		\$1,270,251	\$4,084,343	\$7,153,689
Aniline dyes.....		\$497,106			\$497,106
Logwood extract.....		205,024			\$205,024
All other.....		576,579			\$576,579
Total, dyes and dyestuffs....	\$687,555	\$1,278,709	\$1,270,251	\$4,084,343	\$8,432,298
Exported to—					
France.....	\$30,139	\$203,691	\$18,182	\$237,558	\$505,784
Italy.....	29,682	66,854	237,682	610,531	1,103,900
Russia in Europe.....	56,875		5,922	333,994	57,653
Spain.....	22,031	100,170	13,814	175,586	779,497
United Kingdom.....	128,758	363,827	439,187	483,458	1,924,335
Canada.....	135,442	80,551	347,733	1,190,653	997,337
Mexico.....	2,659	34,729	413	99,697	413,114
Argentina.....	22,696	43,610	25,400	134,457	214,941
Brazil.....	30,820	152,414	3,562	95,090	954,199
British India.....		117,603	577	93,048	408,730
Japan.....	27,924	36,150	98,244	132,863	416,239
Other countries.....	200,518	79,399	70,283	407,416	636,719

*Figures cover period from Jan. 1 to June 30, 1917. †July only.

Influence of Temperature on the Electrical Resistivity and Thermo-Electromotive Potential of Steels*

By Edward D. Campbell†

It is now more than a century since Proust, in France, first stated that white cast iron should be regarded as a solidified solution of carbides of iron in iron, and more than a half century since Matthiessen, in England, also maintained that steel and other alloys should be considered as solid solutions, the electrical properties of which are dependent upon the chemical composition. The solution theory of metals is now nominally accepted by most metallurgists and physicists and yet the question may be raised as to how many experimenters have accepted the essential unity of mechanism of metallic and aqueous solutions, and have based their experimental work on this conception.

In studying the properties of ordinary solutions the part played by the solvent is clearly differentiated from that played by the solutes. It is those solutes which are in solution that are capable of reacting with electrical energy transporting it as an electric current or with radiant energy such as light-producing absorption or refraction. In 1915 (*Journal of Iron and Steel Institute*, 1915, No. II, page 164) the author brought forward experimental evidence to show that the electrical resistivity of steels is a function of the concentration of the carbides or other solutes in solution. A year later (*Journal of Iron and Steel Institute*, 1916, No. II, page 268, and *Transactions of the Faraday Society*, Vol. XII, 1917, page 274) the dependence of the electrical resistivity on the concentration of the solutes was confirmed; and it was further shown that if carbides are the only solutes present the thermoelectromotive potential of these carbides is also a function of the concentration. The hypothesis was advanced at that time that it is the molecules of solutes in solution which are capable of reacting with electrical energy transforming it into heat, thus causing electrical resistivity. Electrical conductance seems to take place almost wholly through the solvent, while the total resistivity seems to be made up of two components—first, that portion due to the solvent, and, second, that due to the solutes in solution. It has been known for many years that the temperature coefficient of electrical resistivity of nearly all strictly pure metals is approximately constant between 0 deg. C. and 100 deg. C., while the temperature coefficient of impure metals and alloys is always lower than that of pure metals, often being very small or even negative. In determining the temperature coefficient of resistivity it is customary to determine the specific resistance of the metal as a whole at two or more temperatures and calculate the change in specific resistance to a percentage basis of the specific resistance at a standard temperature. No attention is paid to the solution theory of metals, for the real acceptance of this conception would require that the total specific resistance be regarded as made up of two components—first, that due to the solvent, and, second, that due to the solutes, with the presumption that the laws governing the two portions might differ.

If, under the solution theory, the total specific resistance is to be regarded as made up of two compo-

nents, it would be only reasonable to expect that under the same conception the thermoelectromotive potential of a metallic solution might also be regarded as made up of two components—that due to the solvent and that due to the solutes in solution.

The principal objects of the present investigation, the laboratory work of which was carried on by William C. Dowd, M.S., were to bring forward some further experimental evidence of the essential unity of mechanism of metallic and aqueous solutions and to show that while the electrical properties of metals are dependent upon the chemical constitution, the effect of changes in temperature of measurement on that portion of the properties due to solvent are not the same as those controlling that portion due to solutes in solution.

EXPERIMENTAL

Steel is one of the best materials with which to study the solution theory of metals because the solvent iron is capable of existing in at least two allotropic forms, and certain solutes, noticeably carbides, are quite readily soluble in iron in the *gamma* condition, although only slightly soluble in *alpha* iron. It is the difference in the solvent and dissociating power of iron in its various allotropic forms that enables the concentration of certain solutes, particularly carbides, to be controlled by heat treatment; thus modifying the chemical constitution without change in the ultimate composition. The stock samples of steels used in the present research were furnished by the courtesy of the American Rolling Mill, the Bethlehem, the Carpenter, the Halcomb and the Midvale Steel Companies, and have the composition shown in Table I, in which the steels are arranged in order of the carbon content.

TABLE I.

Steel	Carbon, per Cent	Manganese, per Cent	Phosphorus, per Cent	Sulphur, per Cent	Silicon, per Cent	Copper, per Cent	Nickel, per Cent	Chromium, per Cent	Tungsten, per Cent
INI	0.018	0.016	0.005	0.018	...	0.018	...	...	...
SN3	0.104	0.122	0.03	0.025	3.649	...	...	...	...
M8	0.326	0.405	0.013	0.026	0.162	...	4.48	...	...
H12	0.61	0.25-0.35	0.020	0.020	0.20-0.30	...	...	0.20-0.30	5.00-5.25
C5	0.945	0.189	0.013	0.016	0.155	...	...	...	...
SN1	1.11	0.40	0.020	0.038	1.20	0.06	0.31	0.348	...
MN1	1.18	11.57	0.055	0.023	0.25	...	...	...	...
INC	1.18	0.016	0.005	0.018	...	0.018	...	...	...

With the exception of the sample marked INC, stock samples of all the steels were annealed by heating over night in an electrically heated furnace to the temperature given in each case and allowing the steel to cool with the furnace for twenty-four hours. From the stock bars, which were thus very carefully annealed under conditions which would completely prevent oxidation, small experimental bars 6 millimeters square and 15 centimeters in length were machined out. These experimental bars were used for studying the influence of heat treatment on the electrical properties.

The sample marked INC was prepared by carburizing small bars of INI, twelve of these small bars being carefully packed in a carburizing mixture made up of one-fourth barium carbonate, one-fourth animal charcoal and one-half wood alcohol. The muffle containing the bars packed in the carburizing mixture was heated over night in an electrically heated furnace, the maximum temperature reached the next day being 969 deg. C. The temperature was then maintained for two days between 960 deg. C. and 945 deg. C., allowed to cool

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over night to 845 deg. C., maintained one day at 845 deg. C., and the next day held between 820 deg. C. and 800 deg. C., after which the furnace was allowed to cool to room temperature. Analysis of the bars showed 1.18 per cent carbon, and a micro-section showed that carburization had proceeded through the entire bar; in fact, the excess cementite tended to be more marked in the center than near the periphery of the bars.

In order to harden the steels, bars were suspended in an electrically heated furnace which had been previously brought to the temperature from which it was desired to quench. The furnace was so arranged that the bars could be suspended in it for an indefinite length of time without any oxidation taking place. The bars were kept in the furnace for one hour to ensure their attaining the same temperature as that of the furnace, which was measured by means of a standard platinum-rhodium thermocouple, placed within two or three millimeters of the bars. When the bars had come to constant temperature they were withdrawn from the furnace and quickly cooled in a large volume of iced water. The time required to transfer a bar from the furnace to the cooling bath, taken with a stop-watch, averaged four-fifths of a second. The time required to cool from the quenching temperature to a black heat outside was from four-fifths of a second to one second, and until the bars reached the temperature of the cooling bath from five to six seconds. During the time the bars were being transferred from the furnace to the quenching bath a film of oxide was formed on the surface, but this was so slight as to constitute only a discoloration.

When the bars had been quenched they were carefully polished and measurements made of the specific resistance at 25 deg. C., and of the thermoelectromotive potential over a temperature gradient of 0 deg. C. to 25 deg. C., the freshly quenched bars being opposed to annealed bars of the same steel. Since it was desired to study the influence of temperature of measurement on the specific resistance and thermoelectromotive potential of the steels and since the solid solution in freshly quenched steel is distinctly unstable, it was necessary to bring these steels to a state which would be fairly stable at temperatures up to 100 deg. C. This was done by placing the freshly quenched bars, after the measurements of specific resistance and thermoelectromotive force at 25 deg. C. had been made, in an electrically heated drying oven maintained at 105 deg. C. and allowing the bars to temper at this temperature from two to three days. After tempering at 105 deg. C. in this way measurements of the specific resistances were made at 25 deg. C., 40 deg. C., 60 deg. C., 80 deg. C. and 100 deg. C., and also of the thermoelectromotive potentials over the temperature gradients 0 deg. C. to 25 deg. C., 40 deg. C., 60 deg. C., 80 deg. C. and 100 deg. C., the tempered bars being opposed to annealed bars of the same steel.

The resistivities were determined by measuring the fall in potential between knife-edges clamped to the bar 10 centimeters apart, while a current of constant density was flowing through the bar. The fall of potential was compared with that given by a standard resistance which had been calibrated by means of a Siemens and Halske potentiometer and a certified standard cell. The knife-edges are bolted to a small glass plate to ensure constancy of distance apart, and the bars, during the measurements, were immersed in a bath of

paraffin oil, the temperature of which could be maintained at any desired point during the measurement. Measurements could be easily duplicated to within less than 0.05 microhm, and it is thought that the values given do not differ more than 0.2 microhm from their absolute value.

The thermoelectromotive force developed over the temperature gradient 0 deg. C. to 25 deg. C., 40 deg. C., 60 deg. C., 80 deg. C. and 100 deg. C. was determined by the following method: Three bars of the same steel and of the same heat treatment were fastened together by means of small pure iron clamps so as to form a triple bar about 43 centimeters in length. One end of this triple bar was clamped to one end of a similar triple bar which in the case of freshly quenched or tempered bars was made up of three small bars of the same steel in the annealed condition. The thermoelectromotive potential of annealed bars was obtained by opposing to a triple bar of the annealed steels a triple bar made up of pure ingot iron. The compound bars were so shaped that the point of connection of the heat-treated and annealed triple bars was immersed in the oil bath also used for specific resistances. By means of small clamps machined out of carefully annealed ingot iron, pure iron wire leads were attached to the outer ends of the two triple bars. The upper temperature was that of the oil bath in which the connected inner ends of the two triple bars were immersed. The lower temperature of the gradient was obtained by supporting the outer ends of the triple bars in two large assay crucibles filled with crushed ice. A vertical slot 7 or 8 millimeters wide and 5 centimeters deep was sawed in each crucible, the bottom of the slot serving as a support for one end of the triple bar. A small hole was drilled in the bottom of the crucible to prevent accumulation of water and the crushed ice was prevented from falling out through the slot by a small piece of sheet copper, bent so as to hang from the top of the crucible on the inside, but not quite reaching to the bottom.

The ends of the pure leads not connected to the compound bars were attached by means of small connectors to the copper conductors leading to the galvanometer. The connectors joining the iron leads and copper conductors were placed in a small bottle of paraffin oil, the object of this being to ensure both connectors being at the same temperature. The galvanometer used is the same as that employed in measuring specific resistances and the deflections are converted into micro-volts by comparing with those obtained by connecting to a standardized resistance through which a known current was passed. Six micro-volts produced one millimeter deflection on the galvanometer scale, on which by means of a telescope and cross hair tenths of a millimeter can be estimated. Duplicate determinations could be kept inside of five or six micro-volts, and it is thought that the values obtained are not more than ten micro-volts from their true value.

The specific resistances of the pure iron and seven steels are shown in Table II, in which table the steels are arranged according to their carbon content. In this table the first column indicates the name of the steel; the second, the per cent of carbon; the third, the heat treatment; the succeeding five columns give the specific resistances at the different temperatures, while the last column gives the increase in specific resistance

from 25 deg. C. to 100 deg. C. The difference in the specific resistance of freshly quenched samples and the same steels after tempering at 105 deg. C., both being measured at 25 deg. C., clearly shows the instability of the solid solution in freshly quenched metal and why it was necessary to temper at 105 deg. C. if consistent results were to be obtained with temperature of measurement as high as 100 deg. C.

are given in Table III and are shown graphically in Fig. 1, in which also is shown the absolute resistivity of pure iron.

The results of the thermoelectromotive potential measurements are given in Table IV, in which the steels are arranged in the same order as in the preceding table and shown graphically in Fig. 2. In this table the thermoelectromotive potential of the freshly quenched

TABLE II

Steel	Per Cent Carbon	Heat Treatment	RESISTIVITY MEASURED AT					Increase of Resistivity 25° C.-100° C.
			25° C.	40° C.	60° C.	80° C.	100° C.	
INI	0.018	Annealed from 778° C.	10.64	11.43	12.49	13.67	14.91	4.27
SN3	0.104	Quenched from 1002° C.	55.39	55.71	56.38	57.10	57.95	2.73
		Quenched and tempered at 105° C.	55.22	55.91	56.66	57.46	58.45	3.08
M8	0.326	Annealed from 985° C.	53.37	53.91	54.66	55.46	56.45	3.08
		Quenched from 900° C.	29.53	29.33	30.42	31.64	32.84	4.24
H12	0.61	Quenched and tempered at 105° C.	28.60	29.33	30.42	31.64	32.84	4.24
		Annealed	25.29	26.02	27.17	28.41	29.72	4.43
C5	0.945	Quenched from 900° C.	30.39	30.39	30.39	30.39	30.39	0
		Quenched and tempered at 105° C.	26.48	27.27	28.40	29.72	31.12	4.64
SN1	1.11	Annealed from 720° C.	19.15	19.94	21.08	22.35	23.75	4.60
		Quenched from 902° C.	37.48	37.48	37.48	37.48	37.48	0
MN1	1.15	Quenched and tempered at 105° C.	26.15	27.07	28.40	29.79	31.25	5.10
		Annealed from 903° C.	16.96	17.63	18.78	20.07	21.48	4.52
INC	1.18	Quenched from 1002° C.	68.87	68.87	68.87	68.87	68.87	0
		Quenched and tempered at 105° C.	63.59	64.45	65.63	66.83	68.05	4.46
MN1	1.15	Annealed from 950° C.	41.62	42.36	43.39	44.45	45.72	4.10
		Quenched from 1002° C.	68.68	68.68	68.68	68.68	68.68	0
MN1	1.15	Quenched and tempered at 105° C.	68.54	69.73	71.55	73.43	75.32	6.78
		Annealed from 810° C.	54.31	55.19	56.70	58.42	60.31	6.00
INC	1.18	Quenched from 902° C.	47.44	47.44	47.44	47.44	47.44	0
		Quenched and tempered at 105° C.	30.32	31.58	33.31	35.10	37.07	6.75
INC	1.18	Annealed from 905° C.	15.81	16.82	18.23	19.67	21.14	5.33

Since such a large proportion of the total resistivity is due to solutes in solution and since annealing produces precipitation of some of the solutes, particularly carbides, if we subtract from the resistivity of tempered steel the resistivity of the same metal in the annealed condition we would have that portion of the electrical resistivity which is due to those solutes which are in solution in the tempered, but not in solution in the annealed steel. These differences of resistivities

and that of the samples tempered at 105 deg. C. is the potential due to those solutes which are in solution in the quenched or tempered samples, but which are not in solution in the same steel in the annealed condition since in making these determinations the steel in the annealed condition is opposed to the same steel quenched or tempered, as the case may be. The thermoelectromotive potential of the annealed steels was the difference in the thermoelectromotive potential of the an-

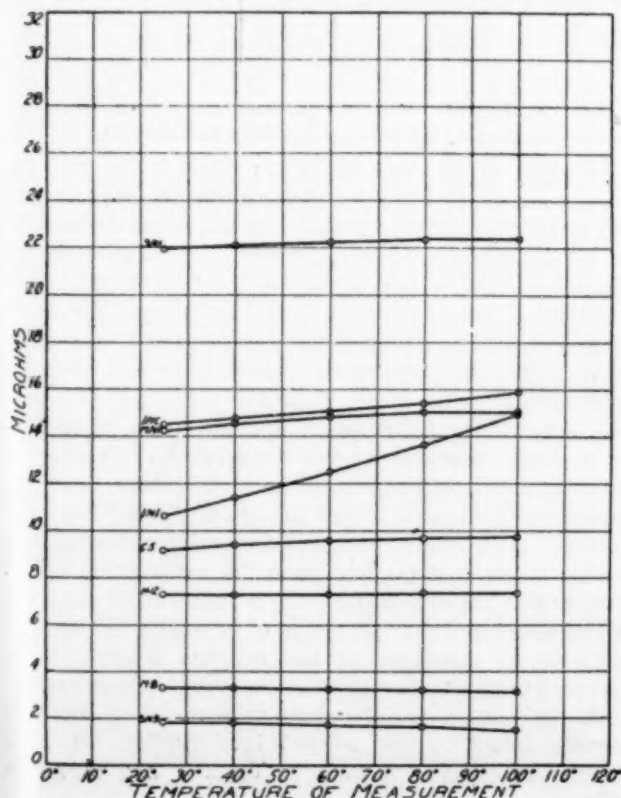


FIG. 1.

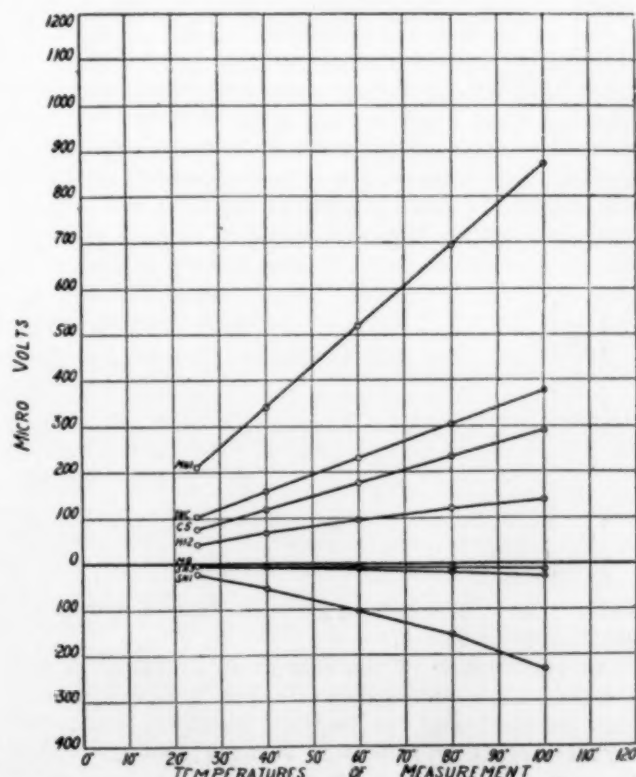


FIG. 2.

TABLE III

Steel	Per Cent Carbon	DIFFERENCE OF RESISTIVITY OF STEEL TEMPERED AT 105° C. AFTER QUENCHING AND SAME STEEL ANNEALED MEASURED AT					Increase in Resistivity of Solutes 25° C.-100° C.
		25° C.	40° C.	60° C.	80° C.	100° C.	
SN3	0.104	1.85	1.80	1.72	1.64	1.50	-0.35
M8	0.326	3.31	3.31	3.25	3.23	3.12	-0.19
H12	0.61	7.33	7.33	7.32	7.37	7.37	0.04
C5	0.945	9.19	9.44	9.62	9.72	9.77	0.58
SN1	1.11	21.97	22.69	22.24	22.35	22.33	0.36
MN1	1.15	14.23	14.54	14.55	15.01	15.01	0.78
INC	1.18	14.51	14.76	15.08	15.43	15.93	1.42

nealed steel and that of pure iron, since in making these determinations bars of the annealed steels were opposed to triple bars of ingot iron. The thermoelectromotive potential of quenched or tempered bars may be readily calculated by adding the thermoelectromotive potential obtained when these bars are opposed to the same steel annealed to that obtained when the annealed bars are opposed to ingot iron.

In Table V are given the thermoelectromotive potentials of three steels in both the annealed and tempered

measurement goes, as does the electrical resistivity of pure iron, the solvent. The electrical resistivity due to carbides increases somewhat with the temperature of measurement, although the coefficient of this increase would not be more than about one-fourth that of pure iron, while the electrical resistivity due to silicides in solution has a small negative temperature coefficient. The temperature coefficient of the electrical resistivity due to tungsten or nickel in solution seems to be also slightly negative.

Viewed in the light of the solution theory in the full sense of the term, the influence of heat treatment on the resistivity of steels becomes quite clear. If in any solution it is those molecules of solutes in solution which are most reactive toward different forms of energy, then a piece of steel in the freshly hardened condition should have its maximum specific resistance since such a piece of freshly hardened metal would have the maximum proportion of its solutes in solution and consequently these solutes would transform a maximum amount of electrical resistivity. The electrical re-

TABLE IV

Steel	Per Cent Carbon	Heat Treatment	Opposed to	THERMO E. M. F. MEASURED AT					Increase in Th. E. M. F. of Solutes 25° C.-100° C.
				25° C.	40° C.	60° C.	80° C.	100° C.	
SN3	0.104	Quenched from 1002° C.	SN3 annealed	0	.....	.....	.....	.....	.....
		Quenched and tempered at 105° C.	SN3 annealed	-3	.....	-10	-16	-27	-24
		Annealed from 985° C.	Ingot iron	556	890	1334	1772	2206	1650
M8	0.326	Quenched from 900° C.	M8 annealed	-3	.....	.....	.....	.....	.....
		Quenched and tempered at 105° C.	M8 annealed	-4	.....	-6	-8	-12	-5
		Annealed	Ingot iron	371	506	894	1186	1468	1097
H12	0.61	Quenched from 900° C.	H12 annealed	80	.....	.....	.....	.....	.....
		Quenched and tempered at 105° C.	H12 annealed	44	68	96	120	138	94
		Annealed from 720° C.	Ingot iron	138	218	320	412	490	352
C5	0.945	Quenched from 902° C.	C5 annealed	192	.....	.....	.....	.....	.....
		Quenched and tempered at 105° C.	C5 annealed	76	118	176	234	290	214
		Annealed from 903° C.	Ingot iron	128	204	292	374	452	324
SN1	1.11	Quenched from 1002° C.	SN1 annealed	-4	.....	.....	.....	.....	.....
		Quenched and tempered at 105° C.	SN1 annealed	-22	-54	-102	-156	-232	-210
		Annealed from 950° C.	Ingot iron	362	578	862	1126	1382	1020
MN1	1.15	Quenched from 1002° C.	MN1 annealed	216	.....	.....	.....	.....	.....
		Quenched and tempered at 105° C.	MN1 annealed	212	340	518	694	872	660
		Annealed from 810° C.	Ingot iron	334	524	764	990	1210	876
INC	1.18	Quenched from 902° C.	INC annealed	262	.....	.....	.....	.....	.....
		Quenched and tempered at 105° C.	INC annealed	102	158	20	302	376	278
		Annealed from 905° C.	Ingot iron	90	138	200	258	302	212

condition when opposed to pure iron. The reason for selecting these steels is that in the steel marked INC we have a high concentration of carbides only as the solutes, in SN3 there is a very high concentration of silicides with a small content of carbides, and in SN1 there is a rather high concentration of both carbides

sistivity of steel is a function of the total molecular concentration of all solutes actually in solution.

A study of the data in Tables IV and V and of the curves shown in Figs. 2 and 3 reveals at once that the thermoelectromotive potential due to solutes in solution is not a function of the molecular concentration of the solutes actually in solution, as is the electrical resistivity. From the data in Table IV and curves in Fig. 2 it will be noted from steels C5, INC and MN1 that, within limits of experimental error and over the temperature range 0 deg. C. to 100 deg. C., the thermoelectromotive potential due to a single solute in solution is a linear function of the temperature. In case of two or more solutes in solution at the same time this would not hold, as is shown in case of steels SN1, SN3, M8 and H12. This thermoelectromotive potential of a single solute is dependent upon the composition of the solute and its concentration. A hypothesis that the thermoelectromotive potential of a solute in metallic solution is analogous to the solution tension of an electrolyte in an aqueous solution, would offer a reasonable explanation for the thermoelectromotive potential results found in the present investigation. This is best shown from the data in Table V and curves in Fig. 3.

TABLE V

Steel	Per Cent Carbon	Heat Treatment	Opposed to	THERMO E. M. F. MEASURED				
				25° C.	40° C.	60° C.	80° C.	100° C.
SN3	0.104	Annealed from 985° C.	Ingot iron	556	890	1334	1772	2206
		Quenched and tempered at 105° C.	Ingot iron	553	894	1324	1756	2179
SN1	1.11	Annealed from 900° C.	Ingot iron	362	578	862	1126	1382
		Quenched and tempered at 105° C.	Ingot iron	349	524	760	970	1150
INC	1.18	Annealed from 905° C.	Ingot iron	90	138	200	258	302
		Quenched and tempered at 105° C.	Ingot iron	192	296	430	560	678

and silicides. The results given in Table V are shown graphically in Fig. 3.

An examination of the data given in Tables II and III and of the curves shown in Fig. 1, clearly reveals that the portion of the electrical resistivity due to the carbides or other solutes in solution does not follow the same law, as far as the influence of temperature of

If an electrolytic cell be set up with a single electrolyte A, the electromotive force of such cell will depend upon the solution tension of the electrolyte and the concentration. If a second cell with a single electrolyte B, whose solution tension is higher than that of A, be set up, it will also have an electromotive force dependent upon the solution tension and concentration of the electrolyte B. If a third cell be set up with a mixture of the electrolytes A and B, it will have an electromotive force intermediate between that of A and B, always being higher than that which would be found with A alone, but lower than if B were the only electrolyte. Electrical conductance in aqueous solutions is dependent upon the total ionic concentration, but is not dependent upon the solution tension of the solutes, this latter being wholly dependent upon chemical composition.

In steel INC we have a single solute, carbides, the thermoelectromotive potential of which is dependent upon the concentration of the carbides brought into solution by hardening. The thermoelectromotive potential of the hardened metal is higher than that of the same steel in the annealed condition. In case of the steel SN3 we have a very high concentration of silicides which seems to be almost as soluble in *alpha* iron as in iron in the *gamma* form; but in the annealed metal the carbides corresponding to 0.104 per cent carbon would be almost completely precipitated. On harden-

ing such a metal the carbides would go into solution and we would have in solution a high concentration of silicides together with a low concentration of carbides and, in consequence, a thermoelectromotive potential slightly lower than that which is given by the annealed steel in which the silicides alone were in solution. Owing, however, to a slight increase in molecular concentration of solutes in the hardened metal, the electrical resistivity is correspondingly increased. This effect of two solutes in solution is shown still more strikingly in the case of SN1 in which we have 1.20 per cent and 1.11 per cent carbon. In the annealed condition the greater part of the carbides would be precipitated and the thermoelectromotive potential would be due to the silicides alone. On hardening, however, the carbides would pass into solution, and since the thermoelectromotive potential of carbides is much less than that of silicides, the thermoelectromotive potential of the hardened or tempered metal would be lower than that of the same metal annealed, although the specific resistance would be very much increased.

SUMMARY OF CONCLUSIONS

1. The total electrical resistivity of steel is made up of two components, that portion due to the solvent iron, and that portion due to solutes in solution, the two portions not following the same laws so far as the temperature of measurement is concerned.
2. The temperature coefficient of the electrical resistivity due to carbides in solution is positive, but only about one-fourth as great as that of pure iron.
3. The temperature coefficient of the electrical resistivity due to silicides, as well as that portion due to tungsten and nickel in solution, is small but negative.
4. The thermoelectromotive potential of a single solute in solution is dependent upon the chemical composition and concentration and is a linear function of the temperature.
5. When two or more solutes are in solution at the same time the thermoelectromotive potential due to these solutes is not a linear function of the temperature and not dependent upon the total molecular concentration.
6. To account for the observed phenomena of thermoelectromotive potential, the hypothesis is advanced that the thermoelectromotive potential of solutes in metallic solution is analogous to the solution tension of electrolytes in aqueous solution.

University of Michigan.

Warning Against Hoarding of Coal

The United States Fuel Administration announces to industrial consumers and manufacturing establishments that if any shortage of domestic coal develops it is due to the individual hoarding of coal and may result in its redistribution by the apportionment and distribution division of the United States Fuel Administration. The production of anthracite coal for the present year will be 10 per cent in excess of the production for 1916. The demand is also greater. Figures are not available as to the increase of production in bituminous.

The Fuel Administration has information and is conducting a general inquiry in the direction of the storing of coal by industrial consumers and various manufacturing establishments.

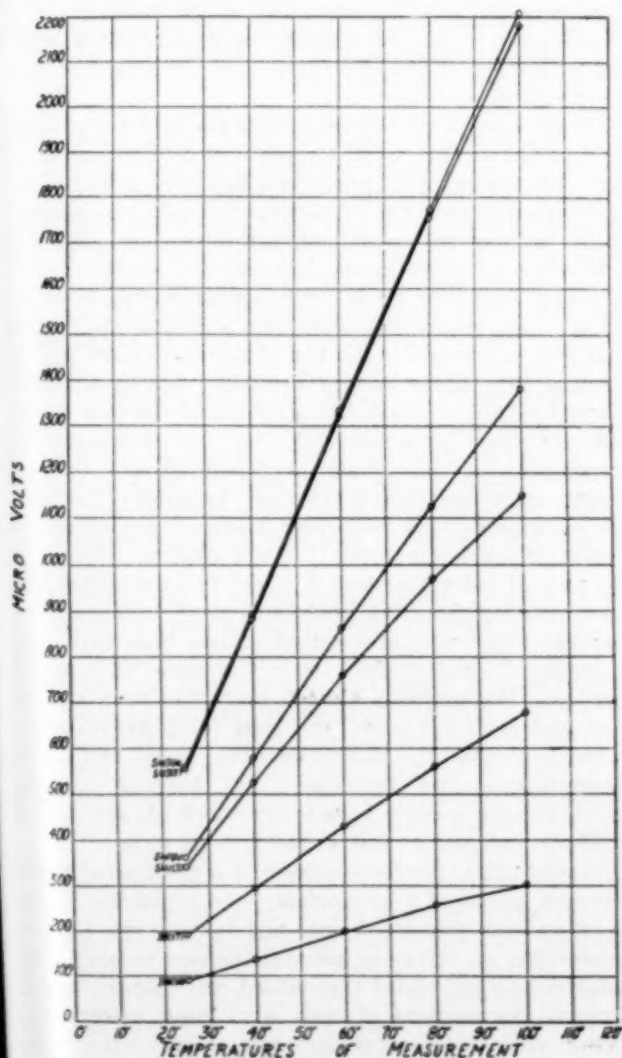


FIG. 3.

A Permanent American Dyestuff Industry*

By H. Gardner McKerrow†

There have been many romantic chapters in the industrial history of the United States, apparently insuperable difficulties overcome and obstacles surmounted, but it is doubtful if history will accord a greater measure of appreciation to any than it will to the way in which, in the brief period of two years, American manufacturers have met and substantially conquered the dyestuff situation. Prior to the breaking out of the European war our dependency on foreign countries for the needs of our color using industries was practically absolute. Approximately 90 per cent of the artificial colors used at that time were imported, and even as regards the 10 per cent which was manufactured in this country, the American dyestuff maker was largely dependent on foreign sources of supply for his intermediates.

At that time there were only five concerns engaged in the making of coal tar colors, and these were continuing their operations either at an actual loss or at least without profit, and in the somewhat forlorn hope that there would be some development, either in the form of more considerate legislation, or extended markets, which would justify their courage and persistence.

The production of crudes and intermediates was in an even less encouraging condition, and with a long continued minimum of demand from the Government for those intermediates which would be employed in the making of munitions, during "the piping times of peace," there was little inducement for capital to seek avenues of employment in the exploitation of coal tar products.

In addition to the artificial dyestuffs used prior to July, 1914, possibly 10 per cent of the color requirements of this country was supplied by the natural dyestuffs or dyewoods, such as logwood, fustic, cutch, gambier, quercitron, sumac and the various redwoods from which such dyes as hypernic are made. Of these, two only were native products of this country, quercitron, which is the extract of black oak bark, and sumac, the product of the leaves of the well known native shrub of that name.

The exigencies of the situation since the war commenced have sent investigators far afield to discover new sources of color, and among an immense mass of more or less useful data and experimentation one native product stands out pre-eminently and takes its place as a worthy companion of the two older native coloring mediums—osage orange, to which I shall have occasion to refer with greater detail later.

Of the natural dyewoods which were drawn from foreign countries logwood from Jamaica, Mexico and Haiti; fustic from Cuba and Mexico; cutch and gambier from India and Burma; Brazil wood from Brazil; Lima wood from Peru, it may be said that the same causes which called them into exceptional demand also made them more difficult to obtain, by reason of the shortage of shipping facilities, the imposition of embargoes, and other conditions made necessary by war developments.

At times during the past two years it has been impossible to secure regular and sufficient supplies of these materials, and this added to the cutting off of

the supply of artificial dyestuffs, and intermediates from Germany precipitated an incipient panic among our mills which will be only too well remembered by members of this association, and during which prophecies of the shutting down of industrial plants, and the approaching inability of our factories to supply anything but white goods were generally made.

Since that time, in addition to the original five companies engaged in making artificial dyestuffs, upwards of 90 enterprises, large and small, some making only one special color, others making more or less extended lines, have come into existence, and over 100 concerns are now engaged in the manufacture of the crudes and intermediates from which the colors must be made.

Mr. Stone has told us of the work that has been accomplished by the older and more experienced makers, as well as by some of the newcomers in the industry; of the colors that have been added to the original list of American made colors; of the industries that have been rescued from imminent stultification, and have been restored to a position where they can still supply the demands of their customers, and deliver the shades and colors to which they have become accustomed.

Granted that we now have, not the nucleus only, but a well grown actuality, even if not yet approaching maturity, in the matter of a dyestuff industry, it is not too soon to consider the ways and means to make that industry a permanent asset in the industrial life of this country, and not a merely ephemeral effort, meeting with more or less efficiency, an exceptional and temporary need.

Of the several requisities to this end which I propose to consider at this time, I place first and foremost, as far transcending any other condition, the absolute and indispensable necessity of earnest and patriotic support on the part of the manufacturers themselves. By this I do not mean a willingness to support the new industry by using American made colors simply during the time when no others are available, with a mental reservation that you will revert to the use of German colors just as soon as they again become available, but by a broad-minded realization that the interests of the new industry are your interests, and that its permanent intrenchment in the industrial family of our country means an added success to your particular industry, and an asset on your particular balance sheet which you cannot afford to disregard. It will require patience on the part of the color user; it is not to be expected that the dyestuff makers can produce in all their characteristics and amplitude, in a period of less than two years a range of shades which took Germany 30 years to develop. The progress already made has been marvellous, and color for color, and type for type, it can be fairly said that the American dyes, made from pure intermediates and following the chemical formulae which foreign makers have made standard, are just as brilliant, and just as fast as the foreign dyes.

Shortly after it became evident that the United States seriously proposed to emancipate her industries, as far as colors were concerned, once and for all from German domination, an insidious propaganda was carefully and industriously circulated throughout this country largely through the medium of certain clothing associations, acting consciously or unconsciously as circulating channels, that American dyes were not fast, and could not, therefore, be guaranteed. To this day it is possible for

*An address delivered at the Springfield Meeting of the National Association of Cotton Manufacturers.
†Marden, Orth & Hastings Corp., New York.

the buying public to purchase goods over the counters of our retail stores, and he assured that "as the dyes are American, and not German" the goods cannot be, and are not guaranteed. Innocently these retail stores are lending themselves to a characteristically German attempt to poison the mind of the average American man or woman, and instill into them belief that no dyes are fast except German dyes.

Were these people to realize that their action is essentially unpatriotic and un-American, and that it is deliberately playing into the hands of our enemies, it is not to be supposed for a moment that they would continue the practice. As a matter of fact, there never was a pound of even German dyes sold in this country without the stipulation on the package that it was sold "without guarantee," nor was there ever a shade offered on a color card showing German colors without the same reservation.

It is doubtless quite true that in the first year or so after the war commenced a vast amount of goods were placed on the market, both piece goods, yarns and hosiery, on which the colors were anything but fast, and to the extent to which this happened, the public was confirmed in the doctrine with which it was being inoculated. This was before, however, an adequate supply of American colors was available, and these goods were dyed in the panic stricken time when even the very floors of mill store rooms were being scraped for color.

As was very pertinently pointed out in a recent issue of the *Color Trade Journal*, the most extraordinary blends and compounds of tag ends of German colors were used in order to get the shades required, and without any reference to subsequent results.

In the same journal Mr. Edward S. Chapin has also very justifiably pointed out that some shades, obtained during this period by the use of natural dyestuffs, were secured under an entire ignorance of the proper use of mordants, and by methods of dyeing and combinations of treatments which could only give notoriously unfast results.

The new industry is suffering from these conditions to-day, and under the best of circumstances, it will be many a long month before the average housewife will be convinced of the serviceableness of American dyes, and will be willing to exhibit a preference for instead of a prejudice against American goods dyed with American dyes.

The patriotic manufacturer, willing even to make sacrifices in order to do his part in insuring this industry against extinction, will realize that it is his privilege, and his interest, to support the makers of dyes in this country by encouraging their efforts, by patience with their delays, and by condonation of their mistakes until they shall have learned by experience those finer and more intimate secrets of manufacturing methods which Germany only learned after two generations of patient research.

To the everlasting credit of some of our large manufacturers it must be said, and frankly and gratefully said, that they have accorded this co-operation and support to the new industry. They have purchased liberally of the domestic colors, and if the quality of shades obtained have not been just what they wanted in the first instance they have been willing to try again and yet again.

This need of appreciation, however, cannot be ac-

corded to a very considerable proportion of the manufacturers of this country. This proportion has not shown an earnest and patriotic spirit in the encouragement of the new industry and has evinced a somewhat selfish disposition in its attitude towards the efforts that have been so freely and fully undertaken. They have exhibited an impatience with those who were shouldering the burden of creating this new industry and have not realized that the complications of the work were such that it has been impossible to expect immediate results which would be fully on a par with the results achieved by Germany after years of effort.

There has been a disposition on the part of some manufacturers to demand colors which would correspond identically with certain marks and brands which were in common use before the war, and they have not shown a willingness to co-operate with the domestic color manufacturers in arriving at a basis of standardization which would enable a fair comparison to be made between domestic and foreign colors.

Let me give an instance of what I mean. I recently received a letter from a certain manufacturer inquiring for some colors of which he was badly in need, and I will quote a single sentence from this letter: "These must be German colors; I do not care to take any chances with American colors." Now, I do not doubt but that gentleman wears an American flag in his button hole, and possibly his boy is in one of the National Army camps and perhaps he, himself, is a member of the home guard in his own town, but, somehow, I do not envy him his particular brand of patriotism.

I have referred to the question of a standardization. This is the second principal requisite to insure the permanence of the dyestuff industry, and is a question in which the color-using manufacturers are equally interested with the color makers. It is absolutely essential that steps should be taken at once to standardize American colors so that a manufacturer may know the relative values of offerings and just what he is buying in point of color value.

At present each manufacturer, if he has any standard at all, has his own, and the strength of one man's product bears no relation to another's and it is almost impossible to gage the value of a color by the price. If America is to make a permanent thing of its dyestuff industry it must establish its own standards; not the standards of one or more dominating interests working alone and without relation to the industry as a whole, but working co-ordinately with all reliable dyestuff makers.

How this can be done is receiving careful consideration at the present time from the various interests concerned. My own idea is that this can be most fairly and effectively managed by the dyestuff manufacturers themselves. I would suggest, as I have done before, the calling of a conference of the dyestuff manufacturers at which the fundamental principles of this question could be discussed and settled, and at which a permanent board of expert color chemists and manufacturers could be appointed that could act as a bureau of standards, and could authoritatively standardize new colors as they were produced.

I doubt if any permanent satisfaction could be obtained from a Government Bureau of Standards, such as has been proposed. We are tending too much towards a paternalistic government, and are calling for

bureaus for this and bureaus for that, the work of which is seldom as thorough and practical as when it is undertaken as a business proposition by the parties interested. I would recommend, as a means of establishing a ratio between standards agreed upon and the price at which goods should be sold, that the selling price should be per unit of color value. Then, no matter whether the dye was sold as a concentrated powder, or as a paste containing 75 per cent of moisture, no matter to what extent the color might be salted or otherwise adulterated, its relative value as against the standard would be fixed. It would be equally fair and effective for one manufacturer as for another.

A permanent board such as I have outlined could properly fulfil other functions besides that of standardizing colors. It could be the means of defending the standards so established. It could serve as a board of arbitration in all matters of dispute involving the question of quality or correspondence of deliveries to sample. Prompt and expert decisions on such matters would not only save time and endless expense in litigation—which under the legal rules of evidence no layman can hope to understand, and which seem designed rather to conceal facts than to bring them out—but would relieve the congestion of court dockets, which are in all industrial centers choked with cases of dispute as to quality of dyes delivered.

I have seen it stated that there are over 3000 such cases in the New York courts alone; all the result of the last two years' feverish conditions in the dyestuffs market, and all awaiting their turn on a docket which has swamped clerks and courts alike for decision.

This involves also the integrity of contracts, where questions of quality have been raised. A disconcerting disposition has been evidenced on the part of many manufacturers to cancel contracts which were entered into in perfectly good faith by the dyestuff manufacturers whenever the market shows any tendency toward declining values.

In other words, a contract is in many quarters only regarded as a contract when it operates to the advantage of the purchaser. This is distinctly unfair and is an evil which is notoriously prevalent in many other lines and is one which is distinct menace to American business.

It is quite evident that when a dyestuff manufacturer undertakes to supply a given quantity of his products to a manufacturer in, for instance, monthly deliveries for a period of time, he commits himself to certain responsibilities in the way of raw materials from which he cannot relieve himself at will and therefore a cancellation on the part of his customer may cause him very serious loss, to say nothing of the loss of profitable business on which he has counted. In 1915 and 1916, when it was a case of first come first served, contracts for dyes to be taken over a term of years at prices far above normal were eagerly accepted, and conditions were agreed to which justified the description of the situation in those two hectic years as "a seller's market."

So far, in the continued absence of strongly competitive conditions, these contracts have been lived up to fairly well, but as new firms come into the market, as methods of manufacture are improved, and prices are reduced, there is a growing tendency on the part of the buyers to demand protection against a falling

market. When the war ends and conditions of the tides of commerce again flow unobstructedly through the ordinary channels of supply and demand, human nature would have lost one of its most universal characteristics if there were not attempts to avoid the pressure of contracts which had become burdens.

If, when these conditions confront us, we had an impartial expert board to which such questions of contract could be referred by the mutual consent of the disputing parties, when such disputes involved the question of quality as against standard—and this is the ground on which 90 per cent of contract repudiations will rest—the trade would know that decisions could be reached intelligently and promptly, and without the interminable delay of the law.

The third requisite for the permanent establishment of the industry is that the Government should accord an adequate degree of protection, and efficient well-administered laws against the "dumping" of foreign dyestuffs on this market at prices which are below the market prices in the country of origin.

When the war commenced the duty against dyestuffs was 30 per cent ad valorem, and against intermediates 15 per cent ad valorem. While this was a very considerable degree of protection it is evident that it bore most heavily against the higher priced and less used dyestuffs, while the ordinary colors, such as the standard blacks, blues and browns, retailed before the war at from 15 cents to 25 cents per pound, hardly felt the benefit of such an ad valorem impost. These are the colors which are in by far the largest bulk demand, and it was at once evident that when the time came to meet the relentless competition of the German manufacturers struggling to recover some of the lost ground and forfeited markets which insatiate ambition has inflicted upon them, it would be perfectly feasible for them to "dump" these cheaper colors on this market at prices which would defy competition, while making up their margin of profit on the higher priced colors which American dyestuff makers have not commenced to make, and possibly will not make for many years to come.

It has been perfectly natural for our manufacturers of colors to follow the line of least resistance, and to devote their initial efforts to those colors which are in the largest demand, and which are the most easily made, but in so doing they have naturally exposed the newborn industry to attack on its most vulnerable side, unless the Government recognizes the necessity of sufficiently protecting its interests.

To some extent this has been done in the legislation effected last year. In addition to the 30 per cent and 15 per cent ad valorem duty, a specific rate of 5 cents per pound on finished dyestuffs, and 2½ cents per pound on intermediates was added, and a clause intended to prevent "dumping" was enacted into law, all of which was a long step in the right direction, and has given distinct encouragement to capital considering investment in dyestuff making developments. But it is not enough to place the industry beyond risk of dangerous competition when normal conditions are restored. The bill introduced by Congressman Hill, which provided for a specific rate of 7½ cents per pound on finished dyestuffs, and 5 cents per pound on intermediates, in addition to the existing 30 per cent and 15 per cent ad valorem rates, came much more nearly meeting democratic administration.

With their commerce at a standstill, their factories denuded of skilled help, and their financial systems disorganized, those European countries which have devoted themselves in happier times to the development of the science of dyestuff making will leave no stone unturned to get back what they regard as their own, and in commerce, as it has been in matters military, anything is justifiable where a struggle for existence is involved.

It is therefore evident that those who realize that the dyestuffs industry, as a permanent unit of the industrial organization of this country, is an indispensable necessity, should use every effort, individual and corporate, to obtain for it Congressional influence which will give it a fair chance to exist through the days of its incipient growth to a self-supporting and independent maturity.

A Method for the Commercial Analysis of Ferro-Silicon*

By Russell E. Lowe†

This analytical procedure is the result of an extended series of experiments, carried on with the purpose of evolving a rapid and accurate method for the analysis of ferro-silicon without the aid of the powerfully oxidizing fluxes at present used. By "commercial analysis" is meant the quantitative determination of sulphur, phosphorus, manganese, iron, aluminium and silicon, since these elements are the ones generally specified in contracts for the 50 per cent alloy.

The older procedures for the analysis of ferro-silicon require a flux consisting of 20 grams of sodium carbonate and 4 grams of potassium nitrate to break down a 1-gram sample of the alloy. A fusion of this character is decidedly destructive to platinum, and in addition requires almost constant supervision because of its tendency to creep over the side of the crucible. Another, and a great fault of the fusion method is that it is slow. Because of the minute quantities of impurities present in the alloy, a gram sample at least must be used. This means the tedious handling of a large volume of silica, and involves a second fusion since it is impossible to wash silica absolutely free from the heavy metals.

The following method of procedure has been tried on several samples of ferro-silicon that were previously analyzed by an outside laboratory of recognized standing, and in practically all cases the agreement was found to be within the limits of experimental error. The method is recommended as being simple, accurate, rapid, and saving of platinum.

DETERMINATION OF SULPHUR AND PHOSPHORUS

Mix sample thoroughly and powder in a diamond mortar until it passes through a 100-mesh screen. Weigh about 1 g. of the powdered sample into a 100 c.c. platinum dish, add 25 c.c. of concentrated nitric acid, cover with a watch glass and place on a boiling-water bath. When the contents of the dish have reached the temperature of the bath add a few drops of hydrofluoric acid. As soon as the resulting violent reaction has ceased add a second portion of the acid. Continue this procedure

until only a slight residue is visible on the bottom of the dish, then add about 5 c.c. more of hydrofluoric acid. Remove the watch glass, carefully washing any matter adhering to it into the platinum dish with a stream of hot water, and evaporate the solution to dryness. Add 10 c.c. of concentrated nitric acid to the contents of the dish and repeat evaporation on water bath. Dissolve residue in dish with 50 c.c. of a 5 per cent solution of nitric acid, heating to hasten the process.

Add to the dish a concentrated solution of sodium carbonate in small portions and with constant stirring until it is present in slight excess, then transfer the contents to a glass beaker and dilute with hot water to about 200 c.c. Heat contents of beaker to boiling and allow to settle. Filter solution through a 12.5 cm. filter, washing the precipitate five times with hot water.

Sulphur.—The filtrate contains the sulphur, and to it is added an aqueous solution of calcium chloride until the precipitation of calcium fluoride and calcium carbonate is complete. Boil the solution for a few minutes, allow the precipitate to settle, filter through a 12.5 cm. filter paper. Wash the precipitate five times with hot water.

Acidify filtrate from the calcium chloride precipitation with hydrochloric acid. Heat the solution to boiling and add 25 c.c. of boiling 6 N barium chloride. Allow solution to stand in a warm place for one hour, then filter through a 9-cm. No. 42 Whatman filter, or its equivalent. Wash filter with hot water until it is free from chlorides.

Ignite this filter in a weighed platinum crucible, cool in desiccator and weigh the sulphur as barium sulphate. Calculate to sulphur. As in all sulphur determinations it is advisable to run a blank carrying out the procedure as given, omitting of course the sample, otherwise results are apt to be too high.

Phosphorus.—The sodium carbonate precipitate contains the phosphorus, as iron phosphate. This precipitate is dissolved from the filter with hot nitric acid, sp. g. 1.13 (approximately 1 volume of concentrated nitric acid to 3 of water). Fifty c.c. of the acid will be found ample if it is poured through the filter several times. When the precipitate is completely dissolved the filter is washed, first with a 1 per cent solution of nitric acid, then with hot water until it is free from iron.

The solution is now heated to boiling, with the addition of a few drops of a concentrated solution of potassium permanganate, and kept at this temperature for about five minutes. Add a solution of ferrous sulphate in water, acidified with sulphuric acid, until any precipitate of manganese dioxide dissolves and the solution becomes quite clear.

Remove solution from the source of heat and add 50 c.c. of ammonium molybdate solution. Allow to stand for 30 minutes, filter through a 9-cm. filter paper, then wash first with 1 per cent nitric acid solution, second with hot water until the yellow precipitate is free from iron.

After the method of J. O. Handy,¹ transfer the filter paper and yellow precipitate to a glass beaker, add a definite volume of sodium hydroxide solution that has been standardized against a steel of known phosphorus content, and titrate for the excess of alkali with a standardized solution of nitric acid. Calculate to phosphorus.

*A paper presented at the Thirty-second General Meeting of the American Electrochemical Society, in Pittsburgh, Oct. 3-6, 1917.
†Chemist, The Fitzgerald Laboratories, Inc., Niagara Falls, N. Y.

¹Blair, Chemical Analysis of Iron, 7th ed., p. 104.

DETERMINATION OF MANGANESE, IRON, AND ALUMINIUM

Weigh about one gram of the finely powdered sample into a platinum dish and proceed with the decomposition of the alloy in a manner identical with that given in the sulphur-phosphorus procedure, up to and including the first evaporation to dryness.

Cover residue in the dish with 25 c.c. of a 1:5 solution of sulphuric acid. Evaporate solution almost to dryness. Cool. Add 25 c.c. of distilled water, raise contents of the dish to the boiling point, then transfer to a glass beaker. Add 100 c.c. of water, a few drops of concentrated hydrochloric acid and boil until solution is complete. Determine manganese, iron and aluminium in this solution in the regular manner, as given in Blair's "Analysis of Iron and Steel," or any standard work on qualitative analysis.

DETERMINATION OF SILICON

Silicon is calculated by summing up the percentages of the elements determined and subtracting from 100.

For an extremely rapid but approximate determination of silicon, accurate within 0.5 per cent, weigh 0.25 g. of the sample into a weighed platinum dish. Decompose with mixed acids as before. Evaporate solution to dryness. Ignite dish at red heat, cool in desiccator and weigh. Assume residue to be entirely composed of iron oxide. Calculate to iron and subtract this value from the weight of the sample, calling the difference silicon.

Notes on the Analysis

1. Nitric acid must be added first to prevent the volatilization of iron, sulphur, phosphorus, etc., as fluorides.
2. By keeping the solution hot it is possible to maintain a much more even rate of decomposition. When hydrofluoric acid is added to a cold solution the reaction is very apt to start with such violence as to eject the contents of the dish.
3. The treatment with sodium carbonate prior to transferring the solution from platinum to glass is necessary because of the traces of free hydrofluoric acid invariably present in the acid solution. For the determination of sulphur and phosphorus it is obviously impossible to make use of a sulphuric acid evaporation to remove the last traces of fluorine. Likewise, the contents of the dish cannot be evaporated to dryness and baked owing not only to the danger of volatilizing phosphorus, but also to the difficulty of getting the ignited oxides back into solution.
- By the addition of sodium carbonate, the traces of fluorine remaining are converted to the fluoride and this is later removed by precipitation with calcium chloride in the sulphur determination. Before this method was adopted the etching of beakers and cover glasses was quite noticeable, while the presence of gelatinous silica made filtrations most difficult.
4. It is to be noted that in no case is there an evaporation of a ferric chloride solution in contact with platinum. This eliminates another source of loss of that expensive metal.

THE VOLATILIZATION OF PHOSPHORUS FROM FERROSILICON

In the course of the experiments for evolving the rapid method for the commercial analysis of ferrosilicon just described, the analytical procedures as worked out were tested on several samples of ferrosilicon that

had been previously analyzed by the Pittsburgh Testing Laboratories by the regular method of procedure.

The new method gave excellent checks in all but the phosphorus determinations, and here, invariably, percentages were obtained that were approximately half of that quoted, as the following data show:

No. of Sample	Per Cent of Phosphorus	
	P. T. L.	Rapid Method
410	0.022	0.0103
411	0.044	0.022

Feeling quite certain that the fault did not lie in the method but in the sample itself, the author repeated his work, this time using an oxidizing flux of carbonate and nitrate to break down the alloy. The results thus obtained also proved to be about half the reported values for phosphorus.

Sample No. 411 was then returned to the Pittsburgh Testing Laboratories for a new determination of phosphorus. While waiting for their report, an investigation of the laboratory files showed that the first analysis had been made in February, 1908, almost ten years previously.

In due time the Pittsburgh Testing Laboratories reported on the phosphorus content of the sample, their value being 0.020 per cent, a very satisfactory check upon the value, 0.022 per cent, by the rapid method.

From the above it seems reasonable to conclude that the volatilization of phosphorus from ferrosilicon is considerable, even when the alloy is kept in a dry place enclosed in screw-topped glass jars.

Coal Gas as a Gasoline Substitute.—The question of driving motor vehicles with coal gas as a substitute for gasoline continues to attract attention throughout the United Kingdom according to Commerce Reports. The press is devoting much space to the discussion of its advantages and disadvantages. The consensus of opinion appears to be that it is a practical proposition and should be adopted as widely as possible, at least for the present, in order to conserve the gasoline supply. The British Commercial Gas Association has been carefully investigating the subject, and in its report declares that coal gas in the present emergency may be advantageously used as a gasoline substitute by providing a large flexible holder in which the gas is stored approximately under atmospheric pressure.

There are no difficulties in adapting the ordinary engine to run with this fuel, as it may be employed without any structural alterations. Another important point is that no alteration in the carbureter is required. The gas bag is merely placed on the top of the car or van, and has one outlet and one inlet. The gas is carried to the carbureter and thence to the engine. The latter may be switched immediately from gasoline to gas or vice versa.

The experiments of the British Commercial Gas Association led to the conclusion that the equivalent of 1 gallon of gasoline is about 300 cubic feet of gas, but other experiments have given only 250 cubic feet or less, depending on the quality of the gas, which varies from one town to another. In practice it seems that coal gas will show appreciable economy compared with gasoline, as at normal prices gas worth 16 cents would do the work of a gallon of gasoline.

Causticizing Soda Liquors*

By Martin L. Griffin, Wallace H. Howell, Jr., and
George K. Spence†

During the last few years chemical industry has been greatly stimulated by the extraordinary course of events. The cutting off of the supply of many imports from abroad and the demands made by the war have done much to bring this condition about. The builders of chemical appliances have made a distinct contribution by the enterprise they have shown. Very often they have been the leaders in improving and developing processes by making a study of them. The getting together of both builders and users annually at the National Exposition of Chemical Industries in New York will, I am sure, lead to increasing interest as time goes on.

INDICATIONS OF PROGRESS

As an illustration of this progress let me mention one subject of great general importance in chemical processing—the separation of solids from liquids. There are two fundamental ways of viewing this subject: First, by a counter current movement of the elements; Second, by straining or filtering out the solids.

The character and relative value of these elements will influence the choice to a great extent. Minor and incidental considerations must also be reckoned with. The making of caustic soda from the carbonate falls within the scope of this subject, and several new appliances and manipulations have been advanced and adopted for this work. Not until recently have any improvements been made in the manner of preparing the liquors for cooking wood by the soda process.

Therefore it seems timely and fitting for the Committee on Soda Pulp to present this subject to the Association for a wider knowledge and better appreciation of one of these newer developments in chemical industry applicable to the manufacture of pulp by the soda process.

Under the title

A Discussion of Different Processes for Causticizing Sodium Carbonate Liquors and the Separation of the Sludge

We will take up the following systems:

First.—Intermittent precipitation, sedimentation and decantation;

Second.—Continuous precipitation, sedimentation, washing and separation of the precipitate from the solution;

Third.—Intermittent or continuous precipitation, filter-pressing and washing for the separation of solids and liquids;

Fourth.—Intermittent or continuous precipitation, with continuous filtering and washing for the separation of solids and liquids.

THE OLD SYSTEM

Under the first heading is comprised the old process of adding the lime to the solution of soda ash in a tank constructed for this purpose and thereafter settling out the precipitated calcium carbonate and drawing off the

clear liquor. The process of washing, settling and decantation is then repeated until the sludge is as free from alkali as conditions will permit.

The actual chemical processes must of necessity be the same in substance, whatever the subsequent mode of procedure may be. In soda pulp mills where the black ash must be leached out, the lime is added to the liquor in dry form; where caustic soda is made for market from finished soda ash, the process is reversed, and dry soda ash is added to milk of lime. In any case the lime must be brought into contact with the soda ash in solution and boiled to make the process effective. It is from this stage onward that improvements have been made which this committee is about to take up. This first and old process may be set forth in a general way as follows:

1. The causticizer—where the solution of alkali and lime are mixed and boiled. This may be a vertical, open, round tank, with a basket suspended for the lime and an agitator; or it may be a horizontal, cylindrical, closed tank, with manholes, lime baskets, agitator and pipe connections. With this arrangement the boiling may be done with low pressure and the causticizing process made more effective.

It is very important that adequate plans be made for a careful measurement of the strength and volume of the alkali liquor used for each charge, so that the quantity of lime may be accurately adjusted.

2. A series of tanks follow for the subsequent settling, drawing off the liquor, boiling up and washing of the sludge. These tanks and causticizer should be of the same capacity and furnished with agitator and all necessary pipe connections. The process is one of quiescent settling of the precipitate, decanting the clear liquor, washing the sludge by a process of dilution, which practically and theoretically is never complete. The lower the concentration of the liquor to be causticized, the higher will be the causticizing efficiency. It is therefore desirable to make up the liquors of approximately the strength required for cooking the wood. The weak wash liquors must of necessity be disposed of in any system, by washing up strong sludges or used in leaching out the black ash.

Such a system requires a large number of tanks, piping, valves, floor space, buildings, labor, steam, etc.

THE DORR SYSTEM

Under the second heading, the causticizing process is best set forth by the system of the Dorr Company. It has been made continuous by the adoption of continuous agitation and continuous counter-current decantation. By the adoption of this company's equipment all operations become continuous, the soda ash, or soda liquor, and lime in proper proportions are mechanically fed to the first of a series of three reaction agitators which are fitted with steam coils. If the caustic liquors are to be made from soda ash, the wash liquors from the second thickener will gravitate to the first solution reaction agitator to furnish the required fluid volume. In pulp mills, however, this wash liquor must necessarily be used for leaching out the strong tanks of black ash. Three agitating tanks are provided, placed in series, so as to insure a continuous boiling for at least one hour to make the chemical reaction effective.

The pulp or precipitate and liquor flow continuously

*Report of the Soda Pulp Committee read at the joint convention of the Technical Association of the Pulp and Paper Industry, and the Technical Section of the Canadian Pulp and Paper Association at Holyoke, Mass., September 27, 1917.

†Respectively, chairman and associates of the Soda Pulp Committee.

through this series into the first thickener, the overflow from which is the strong liquor.

The underflow from each thickener is controlled by a diaphragm pump which delivers it at such a height that, joined by wash liquor or water, it gravitates to the next thickener in the series. The underflow from the last thickener either runs to waste or to a filter for final dewatering and reburning, if desired. It is claimed that by the use of thickeners a smaller total settling area is required than in intermittent work, since the tanks are working continuously and no time is lost in decanting, discharging and refilling.

The Dorr agitator and thickener are the particular devices placed in the tanks to obtain the efficient results sought, and do not include the tanks, properly speaking. The "agitator" can be operated in any flat-bottom tank, and consists of a central vertical cylinder carried by a shaft supported from the top of the tank and equipped with two arms carrying plows, which travel around the bottom of the tank and draw the pulp to the center. This is raised through the cylinder by means of air and distributed evenly over surface of the tank by suitable revolving launders or troughs. A continuous inflow and outflow is provided.

The "thickener" consists of a slow-moving mechanism placed in a suitable tank, by means of which the operation of settling may be made continuous through the removal of the settled material to a point of discharge. It consists of a central vertical shaft with radial arms equipped with ploughs, to bring the thickened material to a discharge opening at the center, by the slow rotation of the mechanism, where it may be discharged as desired. There is a peripheral launder which collects the clear liquid overflowing at the top of the tank. This whole process is designed for continuous work.

The Kingsport Pulp & Paper Company's new plant at Kingsport, Tenn., is equipped with this system.

It is well to note, in passing, that the Dorr devices have been worked out principally for the concentration of slimes and fine concentrates in the mining industry, in which the carrying fluid is water and has no value. In the manufacture of caustic soda, however, the valuable product is the liquid, while the pulp is a waste by-product. In this case it is extremely important that the fluid product should be delivered in its most concentrated form, particularly so if it must be evaporated. While it is possible to dispose of weak washing liquors effectually by counter-current methods, it involves more plant, labor and losses.

THE THIRD TYPE OF PROCESS

We may illustrate the third type of process, namely, intermittent precipitation, filter-pressing and washing for the separation of solids and liquids, by the Kelly filter press, already installed in several pulp mills.

Chemical filtration consists in cake building and cake washing. If the cake retains valuable salts, they should be removed because of their value; if the cake carries the principal value, it should be washed to remove the impurities. The filter press is adapted to either case and the method of procedure is the same.

Plate and frame presses have been used in chemical operations for many years. They have given good results notwithstanding many deficiencies. In these presses, the cake is formed within the bag, cakes forming on the opposing faces until they grow together.

The filtering capacity continually diminishes until the cake is formed, which will contain a moist core unless time is taken at the expense of capacity.

Such presses required much hand labor and are relatively of small capacity; the washing of the cake must be done by displacement of the unfiltered sludge, remaining within the press, and the filters themselves must be removed for cleansing. They are better adapted to problems in which the cake is the more valuable product, and not well adapted for such work as filtering hot strong caustic solutions.

IMPROVEMENTS AS ILLUSTRATED BY THE KELLY PRESS

Recently, many striking improvements have been made which have furnished the motive for this report. The Kelly press illustrates many of these improvements in intermittent filtration. The essential parts of this press are:

- (1) The supporting frame.
- (2) The press shell.
- (3) The filter carriage.
- (4) The filter leaves.
- (5) The quick-locking head mechanism.

The press is telescopic in design. The filters are inclosed in a tight shell and the cake is built up uniformly upon the outside of large filter bags whose area is not diminished in the process of forming the cake. The filter leaves are built up frames, carrying a four-mesh wire screen, and are entirely inclosed within the bags. They are connected to the head end of the press and discharge their filtrates into a common trough. This whole mechanism, including the head end, is counterpoised on a sloping frame. When in operation the filters are inclosed within the shell, and when ready to be discharged they are withdrawn.

Briefly, a complete cycle of operations consists in pumping the sludge into the filter, under a controllable pressure, until the cake is formed. The unfiltered sludge is then displaced by air pressure and this in turn replaced by air pressure, and this in turn replaced by wash water or other washing media. These operations follow successively under a constant pressure so that the cake may be retained intact until the operation is finished. Whenever it is desired, the cakes can be further dried with steam or air. The press is then opened and the cakes can be removed easily by inflating the bags with air or steam, etc.

Some of the peculiar advantages claimed for this press are:

- (1) Large capacity for space occupied and time consumed.
- (2) Economy in energy, including mechanical power, manual labor, losses of energy by changes of temperature during the process.
- (3) Economy of extraction with a minimum of wash water.
- (4) Presses are built strong with a good resistance to wear and tear.

As applied to the soda pulp process, the strong sludgy liquor should be discharged from the causticizing unit into a tank where one sedimentation and one decantation of the strong liquor should be made. The strong

liquor sludge should then pass directly to the filter press, and the strong filtrate pass on with the strong decanted liquor. The largest product of strong liquor will be obtained. The cake may then be washed and the small volume of weak liquor be disposed of in the usual way. The cake itself is then ready to be discharged. There are many of these presses in use for handling caustic soda sludges, both in pulp and chemical works.

CONTINUOUS FILTRATION

Under the final subdivision of this report we shall deal with continuous filtering.

The actual chemical operation of causticizing may be either intermittent or continuous, though I see no particular advantage in the continuous plan. The batching plan provides for definite quantities per batch, with definite results; the continuous plan involves a definite proportional rate of flowage of all the elements entering into the system per unit of time, and requires more intelligent supervision.

In either case and by any system I would advocate one sedimentation and decantation of the strong liquor as the simplest means for separating the bulk of the strong liquor. Or, if a tank of the "Boston tank" design is used, the causticizing unit may discharge directly, in a continuous flow, into it.

In its simplest form the Boston tank consists of a cylindrical tank with conical bottom, having a distributing trumpet in the center, through which the sludgy liquor enters and at the bottom of which the sludge settles, while the clarified liquor rises to the top and flows away through an annular collecting gutter. A pipe situated at a suitable level provides for the continuous discharge of the sludge to the filter.

The Boston tank is a variation of the Dorr thickener to obtain similar results, and may be used in series for counter current separation of the solids. It is introduced here because it forms part of the system advocated by the Industrial Filtration Corporation, which is a builder of continuous filters.

The rotary continuous filter consists of an open container, in which is suspended a revolving drum, whose periphery is composed of a number of shallow compartments covered by a filtering medium. Each compartment, by means of individual pipe lines, is connected to a perforated trunnion, which turns against a stationary valve cap, to which are attached suction and blow lines. The arrangement is such that suction and air pressure may be applied at different points to each of the compartments during every revolution of the drum, the cake forming on the surface by the suction and discharged at the proper time by the air pressure. It may also be removed by a scraper, or doctor blade. The clear filtrate passes through the connecting pipes to the discharge through the trunnion. The filter is in many respects a combination of the cylinder mold and the revolving suction roll, well known in the paper industry.

Provision is also made for washing the cake and separating the wash water from the strong filtrate. The cake discharges with 35 per cent to 40 per cent moisture.

The one notable thing which has made possible these great improvements in filtering devices is the invention of a metallic filtering cloth capable of resisting corro-

sive action and woven in such a way as to give a clear filtrate.

The filtering drum of this continuous filter is covered with such resisting wire cloth, made of Monel metal.

These continuous filters are being used with good results in many large pulp and paper works and chemical industries.

BUILDING, FLOOR SPACE, POWER AND LABOR REQUIRED TO INSTALL AND OPERATE THESE DIFFERENT TYPES OF PROCESSES

Taking as a basis a mill producing about 100 tons of pulp from poplar wood, the actual alkali required to be causticized daily would exceed 125,000 lb., by the losses incurred in the process. This would approach 100,000 lb. of caustic and be contained in about 160,000 gal. or 21,400 cu. ft. The amount of calcium carbonate resulting from the chemical reaction would be about equal to the amount of alkali, since their molecular equivalents are nearly the same.

To install a sedimentation and decantation process would require a tank floor space of 15,000 sq. ft. provided only one tank volume is turned out every 24 hr. A tank should make two complete cycles daily and in this event the floor space would be reduced half, or 7500 sq. ft. This alone would call for a building 75 ft. by 100 ft., allowing no room for operating. Additional tanks for weak liquors and storage or mixing of cooking liquor must be provided and means for the final disposition of the sludge.

The building should be of good height, not less than 40 ft., and all above ground to secure good light, ventilation and drainage. There should be an upper inclosed deck or gallery to contain the causticizers and a storage of lime conveniently located.

These tanks must all be equipped with agitators and power to drive them. It would probably require an equipment of 100 hp. from capacity to operate such a system, though the actual power required for most of the time would be very much less. It would require three men to operate this part of the plant.

A causticizing plant, according to the Dorr system, would occupy a space approximately as follows:

These are built in 10 tons of caustic soda units. Each unit requires a floor space of 75 ft. by 26 ft. It would require five such units for a production of 100 tons of poplar pulp or 50 tons of caustic soda daily. This would call for a floor space of 75 ft. by 130 ft. It is possible to reduce this floor space by using tray thickeners. These consist of one or more steel trays placed in a settling tank with a set of arms and plough blades for each tray all operated by the same vertical shaft. Such tray thickeners were installed in the Kingsport plant. No additional space would be required for weak liquors since the counter current system provides for this, and no pumps other than the small diaphragm pumps are required.

The total power required for each unit is 5 hp. One man only would be required to operate the whole five-unit plant.

A DIFFERENT BASIS FOR AN ESTIMATE OF CAPACITY

In proposing a system for making liquors where a filter forms an essential element, the capacity of the filter must be the basis. Choosing the Kelly press as one type, two single units, type No. 450, or one twin unit, type No. 1300, would be required.

The floor space occupied by the single press is 5½

ft. by 23 ft. each. Additional space must be provided for tank supplying the presses, for pumps, air compressor and operation.

The presses must be situated at an elevation which will permit of automatically discharging the cake into a hopper and thence to a conveyor beneath. Probably 50 hp. and the services of two men would be ample to operate.

It will thus be seen that the building and floor space for such a plant would be relatively small, the idea being to make as complete a separation of solids and liquids by forced filtration of the original liquor rather than by a progressive separation by dilution of the residue which requires large tank capacity.

The rotary continuous filter operating on strong caustic sludge would receive the sludge from a continuous settling tank as described above. Two of these filters would be required and should be placed with their discharge sides facing each other so that the cake may pass to a common conveyor. These filters occupy a space 8 x 8 x 8 ft. and weigh about 11,000 lb. each.

The filtering drum revolves about 1/3 r.p.m. The only power required for this work would be for an exhaust pump which would act as a blower at the same time to lift the cake over the doctor and for the conveyor. Practically no labor is required, as the process is automatically continuous.

Such then are the essential features of the latest devices and processes for causticizing sodium carbonate liquors with lime for the efficient separation of the calcium carbonate from the caustic liquor.

RELATIVE MERITS AND EFFICIENCY ON THE DIFFERENT CAUSTICIZING SYSTEMS

In discussing the relative merits of the different processes used in the soda pulp mills for changing the sodium carbonate to sodium hydroxide, and their efficiency as regards steam consumption and alkali accounted for, it is necessary to form some basis of efficiency. In the older decantation process, in most general use, time and capacity are the principal efficiency factors.

An alkali room having ten pans (each of such capacity that when charged with sodium carbonate liquor, causticized, properly settled, drawn off and mixed with a properly settled first wash, there will be enough liquor for two digesters) is capable of furnishing liquor enough for twenty digesters in twenty-four hours. In other words, each pan should be allowed twenty-four hours for one complete cycle in order to obtain good economical results. This will allow the strong and first wash each four and a half hours and each of the other three washes three hours to settle before syphoning off the clear liquor. When handled in this way the lime sludge discharged will contain about 85 per cent weak liquor and 15 per cent solids by volume, or 68 per cent weak liquor and 32 per cent solids by weight. The loss of soda in this sludge discharge will be from 1/2 to 3/4 per cent of the total soda used.

Thorough agitation is also a necessary factor in causticizing soda efficiently. If the agitator shaft is provided with one set of wings near the bottom, it should make at least 30 r.p.m.; but provided with three sets of wings at three different heights, the speed of the shaft can be cut to 16 or 18 r.p.m. and give equally good results. Of two mills using the same size alkali

pans, the same quantity of lime, and all other conditions the same, excepting the speed of the agitator shaft, the shaft in one mill made 20 r.p.m. and in the other 30 r.p.m., with the result that the former was obliged to use about 8 per cent more lime than the latter; and, on account of using extra lime to get the same causticity, 6 per cent less liquor was syphoned from the strong pan in the former mill, after allowing the pans to settle the same length of time.

When using a lime containing 94 per cent active calcium oxide, it is customary to use about 560 lb. of lime for each 1000 lb. of sodium carbonate causticized, in order to get a strong liquor having 92 per cent of the total soda causticized. This strong liquor when mixed with a first wash of 97 per cent causticity will furnish liquor of about 94.5 per cent causticity for the digesters. The lime when slacking in the pan of carbonate liquor will furnish about 480 B.t.u. per pound or 268,800 B.t.u. for every 1000 lb. of sodium carbonate causticized. This will raise the temperature of the liquor about 30 deg. Fahr. If the carbonate liquor from the leachers tests 160 deg. Fahr., the lime added will raise the temperature to 190 deg. Fahr., so that it is only necessary to add enough steam to raise the temperature 22 deg. higher to reach the boiling point at the sea level. It is only necessary to boil the pan of liquor about 15 min., when the agitation is good; but agitation should be continued from 20 to 30 min. longer.

At this point I might mention the part the quality of lime plays in affecting the time necessary to boil the liquor. The calcium oxide content of a lime, as found by analysis, very often comes far from representing the active content of the lime. Samples of lime with a total calcium oxide content of 85 per cent have shown an active content as low as 72 per cent. The Soda Pulp Committee, in a previous report, has called the attention to a miniature causticizing test as a satisfactory method of testing lime used in order to determine its active content. The principal cause for the difference between the actual and active calcium aside from that present as carbonate is due to presence of an excessive amount of silica and alumina in the form of silicates, which has been fused by overburning in the kiln, and incloses some of the active lime, making it difficult for the slacking water to reach it. Lumps of this lime will stand in hot water as long as 25 min. without breaking down, while a lump of good slacking lime will break down completely in about 1 min. It will be found advantageous to make a rough slacking test, as above suggested, in the alkali room, when a car of lime appears refractory; and if it requires much time for the lumps to break down better results can be obtained by boiling the pans of liquor an additional half hour. By the decantation process, allowing 24 hr. for one complete cycle, 8 lb. of sodium carbonates can be causticized per cubic foot of pan capacity in 24 hr.

Most of the soda pulp mills have increased their production to such an extent that the alkali room is worked far beyond its capacity; and the result is inefficient operation in this department. The original ten pans are trying to do the work of fifteen, which results in cutting the cycle of time to 16 hr. in place of 24, and causing a loss of from 3 per cent to 4 per cent of the total soda causticized.

The newer processes brought forward in recent years cannot be considered substitutes for the causticizing

process, as the first step in the operation is the same in every case. The sodium carbonate must first be causticized by boiling with lime. It is from this point on that improvements have come to the assistance of the soda pulp manufacturer. By a small addition to his alkali room he is able to secure, with the same number of pans, an increase in capacity of 100 per cent to 150 per cent. The improvements consist in new methods of separating the liquor from the sludge after the causticizing process is finished, effecting a saving of time and space and cutting down the loss of soda in the sludge discharges. A description of such methods has been given in the earlier part of this report, and a brief abstract of their principles and claims will now be given. By a small addition to his alkali room he is able to secure, with the same number of pans, an increase in capacity of 100 per cent to 150 per cent.

The Dorr process is an improved method of doing on a systematic continuous plan what is attempted with a discontinuous intermittent system of disconnected tanks. The process being strictly counter current, it is very efficient in washing the precipitate, sustaining and building up concentrations from the washings.

The Dorr Company's engineer reports that the Kingsport plant, having a capacity of 50 tons dry weight of caustic soda a day, producing 14 deg. Baumé liquor of 92 per cent causticity, has an efficiency of 99.4 per cent. The process is well illustrated and results are analyzed on the "flow sheet." As such it is a decided improvement upon the old system.

There is one important matter which should not be overlooked. The system is not well calculated to retain the initial heat, since the thickeners are very large and shallow. Large open tanks containing hot liquors should be covered or the condition of the room will be very disagreeable, particularly in a cold climate, and there will be large heat losses.

The obvious purpose and intent of the filter-press, however designed and operated, is to effect a thorough and rapid separation of solids and liquids, thereby obtaining a clear filtrate and a clear solid mass in the shortest time, with the least expenditure of capital and labor. The filter press, generally speaking, produces a cake when operating on this caustic sludge, containing about equal parts of solids and liquids, and when washed with a volume of water equal to the cake the caustic losses with the cake are 1 per cent and under. Therefore that system of forced filtration, which will take the hot boiling sludgy caustic liquor from the causticizer, of the desired strength, and effect a prompt and thorough separation, with the least expense for equipment and maintenance building, power and labor, is the system desired. If therefore the intermittent or continuous forced filter will accomplish this, obviously such a system has distinct advantages over any sedimentation plan.

It will, of course, require a higher degree of skill and intelligence to operate the more complicated and highly organized filtering machine than the foolproof old system of sedimentation and decantation in tanks. If we are content with slow, crude and cumbersome methods, we shall choose this. If, however, we want to be leaders in chemical processing, there is much to commend in the newer methods of forced mechanical filtration, intermittent and continuous.

Every problem involving a separation of solids and liquids has its individual and peculiar features, and we should join with the designers and builders of chemical appliances in solving our mutual problems. This meeting and our association are organized for just such problems.

Synopsis of Recent Metallurgical and Chemical Literature

Electrochemistry

Electrochemical Industries of Italy.—*The Chemical Trade Journal and Chemical Engineer*, Sept. 22, 1917, prints an account of the electrochemical industries of Italy, taken from *Zeitschrift für Angewandte Chemie* (date not given). The account states that the numerous sources of waterpower in Italy, especially in the north, have contributed largely to the extension of the electrochemical industry, which is mostly established in Lombardy. The Societa Anomina Ferriere di Voltri of Darie, in the Province of Brescia, have worked a calcium carbide plant since 1908, using waterpower from the Dezze. The furnaces work continually and can produce four tons of carbide daily. Another electrochemical works in Lombardy is the nitric acid factory of the Officine Elettrochimica Dott Rossi of Legnane, which, like the factory of Patsch, near Innsbruck, uses the Pauling method, and obtains the nitric acid by conversion of atmospheric nitrogen. Besides nitric acid, potassium chlorate is also manufactured, which has greatly reduced the amount formally imported from France and England. The yearly production for the year before the outbreak of war was 12,000 tons of 36-42 deg. Be. nitric acid, and 580 tons of potassium chlorate.

In Piedmont the Societa Industriale Elettrochimica di Pont Saint Martin, which was established in 1899, produced calcium carbonate for many years. In the same locality, the Societa Piemontese for the manufacture of calcium carbide and allied products with a working capital of 2,000,000 lire has a plant for the manufacture of calcium carbide and nitrate of potash which is worked by waterpower from the Dora Baitia. For the manufacture of calcium carbide two Tofani furnaces of 2500 and 1200 hp. are used, and suitable lime is obtained from the Meana di Susa quarries. The yearly production is about 2400 tons. Part of the calcium carbide produced is used in the manufacture of calcium nitrate, according to Linde's German method, the yearly production being now 2900 tons; ferrosilicon, silicium and barium sulphate are also manufactured. In summer the plant works uninterruptedly day and night, while in the winter, on account of the shortage of electric current, it is only worked at night.

In the Umbrian provinces there are a number of important works, of which two produce electric power exclusively. The Societa Italiana per il Carburie di Calcio (capital 14,000,000 lire) erected the first Italian calcium carbide factory in 1896, using waterpower from the Velino. They possess at present the three works at Collestata, Papigno, and Narni, with their own electrical stations. Most of the electric energy produced is used in their own works. The Collestata works have been in operation since 1897, and at first manufactured calcium carbide. In the year 1908 the

manufacture of calcium cyanamide was commenced, and the output of calcium carbide declined. Nitrogen is obtained directly from the air by two plants, the first producing 125 and the second 400 cbm. per hour. This factory delivers 15 tons of calcium nitrate daily, together with 15 tons of ammonia sulphate. The Papigno calcium carbide factory has a capacity of 60 tons daily, and produces over two-thirds of the company's production of calcium carbide. The carbide is made by a special process which this firm has patented. The Narni calcium carbide factory was taken over by this company in the year 1908. The factory has a capacity of 40 tons daily.

Two further calcium carbide factories, which do not belong to the above-mentioned company, are to be found in Foligno and Salifano. The factory in Foligno, belonging to Fabbrica Italiana di Carburie Derivati, has greatly reduced its output of calcium carbide in recent years, and has taken up the manufacture of barium sulphate and barium oxide as well as sodium sulphate experimentally. The electrical power is supplied by the Foligno municipal electrical depot. In Salifano there is also a similar plant for the manufacture of calcium carbide. In the Abruzzi the Societa Italiana di Elettrochimica has a chemical works situated on the Rome-Castellamare Adriatic railway, and employs 400 hands. The electrical power is obtained from stations at Ticino and at Primo Salto del Pescara. The plant produces about 3400 tons of caustic soda yearly from rock salt, which is obtained from Sicily. A further 250 tons of sodium chloride is obtained as a by-product of electrolysis. Further 5000 tons of calcium chloride, 500 tons of very pure hydrochloric acid, and 50 tons of carbon tetrachloride are produced. 1200 tons of 50 per cent iron silicate are manufactured yearly by the electrothermic process, using two monophase furnaces of 715 hp. each, and in a triphase furnace of 1500 kw. about 4000 tons of calcium carbide are produced. The consumption of these products is limited almost exclusively to Italy. A factory belonging to the Societa Industriale Italiana di Capistrella (Aquila) also manufactures calcium carbide.

Gas Industry in Wartime in England.—J. H. BREARLEY presented a paper on "Wartime Experiences of Gas Undertakings" at a meeting of the Eastern Counties Gas Managers' Association, held in London, about Oct. 1. The paper is abstracted in the *Chemical Trade Journal* and *Chemical Engineer* and gives important and interesting information. The author said that, taken as a whole, the residual products could not be said to have contributed as much toward working costs as might fairly have been anticipated. Coke had been satisfactory, for the simple reason that, with few exceptions, its sale had been unfettered. Tar for a long time remained a source of anxiety on account of the difficulty experienced in dealing with pitch. Various works experimented with pitch for gas-making; but today little was heard of that method of keeping production within manageable limits, and it seemed to have fallen largely into desuetude. Creosote, from being almost an absolute drug, had become one of the most important distillates; and for its recovery in adequate quantities the greater production of tar was urgently called for. The requirements of toluol and benzol were being adequately met. An incidental result of the pro-

cess of recovering benzol by washing the gas with creosote oil had been to discredit finally the illuminating power test as applied to gas undertakings.

Home demands for munition-making had taken large quantities of concentrated ammoniacal liquor, estimated in 1916 as the equivalent of over 70,000 tons of sulphate of ammonia. In the same year the home consumption of sulphate of ammonia was 178,500 tons, as compared with 128,000 tons the previous year. There were exported 259,500 tons.

The figures at which maximum prices were fixed for sulphate sold to farmers had given very general dissatisfaction among producers. Although they hoped and expected to see the home demand for sulphate grow greatly, their organizations would have to fortify themselves against the powerful influences which the farmers appeared able to invoke if the time ever came when they had to rely solely upon the home markets. Unless circumstances altered, they could not view as an un-mixed blessing a state of affairs in which they were permanently cut off from all export markets. For the time being the advent of war had effectively countered the German efforts to capture the world's markets. When the war was over, British producers might reasonably hope to command a fair share of the foreign trade, if sulphate maintained its position in comparison with other sources of nitrogen. Doubtless the Sulphate of Ammonia Association was looking ahead, and formulating their plans accordingly.

The maximum price fixed for sulphuric acid was much higher relatively than that fixed for sulphate of ammonia. Spent oxide, however, had commanded good prices, and afforded a substantial set-off. The use of nitre-cake for sulphate-making did not appear to have been a success.

Mr. Thomas Glover, in the course of the discussion, said there was a thought which was suggested by the president's address, and that was in reference to purification—the extraction of sulphur and the making of sulphuric acid. When this country went to war, its ability to produce sulphuric acid was very much below the necessities of the case; and as the submarine menace had developed, the difficulty of finding raw material for making sulphuric acid had increased. First it was plant; and then, secondly, it was raw material. Now the gasworks, very quietly and without it being recognized, had been producing a very large quantity of raw material for sulphuric-acid making. The conversion to oxide purification which had become almost general insured that sufficient sulphur would be extracted from the coal to make enough sulphuric acid to neutralize all the ammonia which was also produced from the coal. And in addition to this, a very considerable excess of sulphuric acid was produced from the sulphur extracted from the coal which they carbonized. They had not in the Eastern Counties many large works in which it would pay to put down a sulphuric acid plant to burn their own oxide; but it was possible to make advantageous arrangements with a chemical works to take the oxide, burn it, and supply the sulphuric acid to the gas works for sulphate of ammonia manufacture, and also to return the burnt material to the works. It could by suitable means be rehydrated, and brought back into service; and so the process could go on continuously. It was a thing which, if properly worked, under suitable conditions, could be made to pay the whole cost of puri-

fication and leave a little margin of profit. With reference to the price of sulphate, he agreed with the president that the price fixed by the Government was an unfair one, and that the industry was not called upon to subsidize agriculture—to the great advantage of agriculture, and to the disadvantage of the gas industry. With the price of sulphuric acid so high, the price of sulphate of ammonia should have been fixed higher. Something, too, might be said of the prices paid for benzole and toluol, which were rather below pre-war rates.

Mr. W. W. Townsend said it seemed to him that the direction in which progress was to be looked for in the future was in making coal gas of decent quality, at a moderate temperature, getting good yields of ammonia and oils, and stretching it to get the required quantity by the addition of blue water gas.

Heat Insulation

Comparative Tests of Heat Insulating Materials.—Some interesting tests were recently completed by Sargent and Lundy, consulting engineers, of Chicago, on the relative value of various heat insulating materials. The report was published in *Power*, May 1, 1917.

The first object of the tests was to determine the relative thermal insulating value of the materials examined. The materials were obtained in or were cut to the dimensions of standard bricks, so that in this respect the samples were equal.

The difficulty, which was expected, was found to be in insulating thoroughly the top, bottom and sides of the bricks. Naturally, it is difficult to insulate a material that is itself a good insulator. From these tests there did not appear to be so much difference between the fire and the insulating bricks compared by this method of temperature gradient, and it might be said that, roughly, 6 in. of firebrick is equal to 4 in. of insulating brick, which on general principles is not reasonable.

It is pointed out that, though every precaution was taken to insure comparative conditions, it follows from radiation laws that a very small difference, in various ways, such as the high-temperature source, thickness of insulation between samples, etc., might lead to wrong results and it is well known that magnesia is equal in insulating value to many times its thickness in ordinary firebrick, so long as disintegration does not take place.

It was therefore considered that some other method should be found to obtain a more absolute comparison and that it should be on the basis of measuring the actual quantity of heat passing through the material under test. This would be a true value of the heat-insulating value of the materials.

The method adopted was to build a furnace of the various materials, cut to the dimensions of standard bricks and carefully laid up with small joints. These furnaces were heated by means of an electrical heater made of arc-lamp resistance coils and arranged to evenly distribute the heat over the inside. The electrical energy can be measured with great accuracy and could be exactly adjusted. The electrical input to the heater was converted into B.t.u. by multiplying the watt-hours consumed by 3.412, as it was thought advisable to use the B.t.u. as the unit of heat and not to express it in electrical units.

If the electrical input is constant, then the temperature will rise in the furnace until the temperature difference

between the inside and outside is sufficient to cause the heat generated to be dissipated at an equal rate; then equilibrium is established. On established equilibrium, readings were taken of the electrical energy and the temperature of the inside and the outside of the furnace. By varying the electrical energy a curve can be drawn between the temperature difference of the inside and the outside of the furnace, and the B.t.u. radiated per hour. By this method of testing it is easily seen the great advantage, from a thermal point of view, the insulating materials have over the ordinary firebrick.

To express this variation in insulating value with the temperature, it was thought that a similar relation to Ohm's law might be found. This was proved to be so. The unit taken has been called the "thermal Ohm" and is expressed by dividing the temperature difference by the B.t.u. radiated per hour. The values for the materials have been calculated and these show practically straight lines except for magnesia and a combination of sigur and magnesia, marked Si.-Mag. With this latter material the "thermal resistance" decreases directly as the temperature difference.

To use the figures thus obtained, to find the equivalent thickness of material required to give equal insulation—that is to say, equal thermal resistance, in each case—it is necessary to demonstrate experimentally the laws of thermal resistance. To do this, furnaces of half and twice the thickness of the original furnace were built and tested.

The results proved that the thermal insulation is directly proportional to the thickness.

The material of highest thermal resistance is Sil-O-Cel; the other materials are therefore expressed in terms of this material.

At 2000 deg. F. the relative values are as follows:

1 thickness of Sil-O-Cel equals:	6.5 thicknesses of Osceola firebrick.
	1.85 thicknesses of Diddier insulating brick.
	1.65 thicknesses of Si.-Mag. insulating brick.
	1.35 thicknesses of Sigur insulating brick.
	1.20 thicknesses of Nonpareil insulating brick.

From the known dimensions of the furnaces the B.t.u.'s radiated per hour square foot of surface for various temperature differences are figured. Under similar conditions a Sil-O-Cel wall would radiate 22,250 B.t.u. per hour, or only about 20 per cent as much as the firebrick wall. The following crushing tests are also interesting:

CRUSHING TESTS OF HEAT-INSULATING MATERIALS

	Before Heating Lb. per Sq. In.	After Heating Lb. per Sq. In.
Sigur	357.6	339.7
Sil-O-Cel with strata	171.6	168.0
Sil-O-Cel against strata	404.4	379.0
Sil-O-Cel average	288.0	274.0
Magnesia.	144.0 }	Crumble easily
Diddier.	39.3 }	
Nonpareil.	183.0	168.0

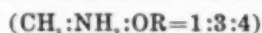
As these tests required a week or two to complete on each furnace, it was no measure of what effect "aging" would have on the material. For this reason furnaces of Sil-O-Cel and Sigur were built and run at temperatures of 1200 deg. F. respectively for over six months continually, with no change in the insulating properties whatsoever and with no damage to the materials themselves.

Recent Metallurgical and Chemical Patents

Dyestuffs

Chromium Compounds of Azo Dyestuffs.—GADIENGT ENGI and CARL JAGERSPACHER of Basel, Switzerland, patent a chromium dyestuff and process of making same. The patent is assigned to the Society of Chemical Industry of Basel. The product is made by treating an orthoaminophenol compound with a chromium compound in a hot aqueous medium, diazotizing the chromium compound of orthoaminophenol compound, combining the resulting chromium compound of orthooxydiazobody with a naphtholic compound and treating finally the thus obtained half chromated orthooxyazodyestuff in a hot aqueous medium with a chromium compound. The dye is stated to undergo no change by adding sodium carbonate or soda lye and to produce fast tints on animal fibre which are not changed when subsequently chromated. (1,242,536, Oct. 9, 1917.)

Disazo Dyes.—RUDOLF SCHÜLE of Frankfort-on-the-Main, Germany, patents a new disazo dyestuff and process of making it. The patent is based upon the discovery that by combining the diazocompound obtained from diazo-p-nitrobenzene and aminocresolalkylether



where R denotes an alkyl group and further diazotation with M-aminophenyl-8-oxy-1.2.naphthimidazole-3.6-disulfonic acid in alkaline solution, a disazodyestuff is obtained which dyes cotton bluish black shades; these may be developed on the fiber, yielding brilliant green shades by further diazotizing and developing with 1-phenyl-3-methyl-5-pyrazolone, phenol, cresol or resorcinol. Brilliant green shades are likewise obtained by after treatment with p-nitrodiazobenzene. The developed dyeings are stated to be of good fastness to washing, soap and light. (1,241,153, Sept. 25, 1917.)

Copper Compounds of Orthooxyazo Dyestuffs.—GADIENGT ENGI and CARL JAGERSPACHER of Basel, Switzerland, patent a process for the manufacture of copper compounds of orthooxyazo dyestuffs. The patent is assigned to the Society of Chemical Industry of Basel. The patentees have found that instead of starting from the orthooxyazo dyestuffs and acting with copper compounds on their solutions, the new copper compounds can also be obtained by effecting the combinations of orthooxydiazophenol-or orthooxydiazonaphthol derivatives with azo dyestuff components, in presence of copper compounds. Thus the copper compounds of the orthooxyazo dyestuffs are produced directly and can be isolated eventually after addition of common salt, by filtration, washing and drying. The process is described in the specifications. (1,237,183, Aug. 14, 1917.)

Leucotriarylmethane Dyes.—FRITZ FUNCKE and CARL JAGERSPACHER of Basel, Switzerland, patent new dyestuffs and a process of making same. The patent is assigned to the Society of Chemical Industry of Basel. The dyestuffs are obtained by diazotizing the amidoleucopatenblue, resulting from the nitration of leucopatenblue and the subsequent reduction of the obtained nitro derivative, and by combining the prepared diazobody with an azo dyestuff component, as for instance an amine, a phenol, a naphthol, an aminophenol, an aminonaphthol or their sulfo or carboxyl derivatives, pyrazolone derivatives, etc. The dyestuffs dye on mordants and are therefore stated to be especially applicable for dye-

ing animal fiber vivid blue to green tints, fast to washing and light, according to the methods usually employed for the dyestuffs which dye on mordants or are able to be chromated on the fiber. They constitute blue to green and yellow powders, soluble in water, with blue to green and yellow colorations and in concentrated sulfuric acid with yellow to violet colorations. (1,237,192, Aug. 14, 1917.)

Copper Compounds of Leucotriarylmethane Dyes.—Another patent of the above parties deals with copper compounds of the above dyes. These dyes are transformed by treatment with copper oxide or copper hydroxide, in an aqueous medium into new copper compounds soluble in water and dyeing animal fibers in an acid bath vivid blue to green tints fast to light, washing and alkali. The new copper compounds constitute blue to blue and green powders, soluble in water with blue to green coloration and in concentrated sulfuric acid with green to red colorations. (1,237,193, Aug. 14, 1917.)

Copper Compounds of Orthooxyazo Dyes.—BARTHOLD WUTH and CARL JAGERSPACHER of Basel, Switzerland, patent a process of making copper compounds of orthooxyazo dyes. This is the process mentioned in above patent 1,237,183. The latter being a variation of this present patent. The present patent refers back to a previous application. It describes the transforming of orthooxydiazodyestuffs derived from orthocarboxylated benzoylacetic acid into new copper compounds by treatment with copper oxide or hydroxide. (1,234,994, July 31, 1917.)

Azo Dyes.—JAMES H. STEBBINS, JR., of New York City, patents new azo dyes and methods of making same. The new dyestuffs are derived from 1.8-dioxynaphthalene-3.6-disulfonic acid, otherwise known as chromotropic acid, by combining this acid with diazotized benzidine, or its equivalent, and with another diazotized aromatic amine, such as diazotized para-nitranilin or diazotized para-amido-phenylglycin or diazopicramic acid; and by further combining with the diazotized benzidine an end component such as 1.5-naphtholsulfonic acid or the 1.4-naphtholsulfonic acid. The dyes are soluble in water and capable of dyeing both wool and cotton without mordants. (1,235,253, July 31, 1917.)

Nitrogen Fixation

Concentration of Nitric Acid.—KRISTIAN BIRKELAND, Christiania, Norway. Process of concentrating the dilute acids obtained by the absorption of nitrous gases, more especially from such nitrous gases as are obtained by the direct combination of air nitrogen and oxygen. According to the patent, the concentration of the dilute acid, which usually has a strength of about 30 per cent, is effected by producing, by means of the acid, a nitrate of a metal and subsequently decomposing the nitrate by treating it with superheated steam and condensing and further treating the vapors so obtained. (1,236,662, Aug. 14, 1917.)

Apparatus for Iron, Coke, Soda-Ash Process.—RALPH H. MCKEE, Ridgefield Park, N. J. Patent relates to a container having interior walls of an alloy of 50-60 per cent nickel, 10-20 per cent chromium, and 10-30 per cent manganese and carbon. Container is stated to exert a favorable effect on the reaction when nitrogen is passed over coke, iron oxide and soda ash for nitrogen fixation. (1,236,853, Aug. 14, 1917.)

Calcium Cyanamid.—JAMES H. REID, Newark, N. J. This patent relates to the fixation of nitrogen and the making of metal cyanamids, and comprises combining nitrogen with metal and carbon by exposing metal carbide to the action of nitrogen and heat in such a manner that the carbide is supplied to the nitrogen at a temperature sufficient to elevate the nitrogen to a point selective to its combination or reaction and fixation and particularly by introducing molten metal carbide, such as calcium carbide, into nitrogen and performing the fixation of the nitrogen upon cooling of the carbide to a selective combining point, with the simultaneous heating of the nitrogen to the initial combining point. (1,241,020, Sept. 25, 1917.)

Nitrogen Fixation with Manganese.—LELAND L. SUMMERS, Chicago, Ill. Process consists in preparing nitrogenous compounds from the nitrogen of the air or other gaseous sources by the use of manganese or its compounds. A compound containing manganese such as the common dioxid of manganese, "pyrolusite," is heated in the presence of carbonaceous matter to form various carbides of manganese. While this reaction is in progress, nitrogen from the atmosphere or other sources is introduced and a reaction takes place, causing various compounds of nitrogen, carbon, oxygen and manganese to be formed, which may be readily recovered as such or as other compounds containing combined nitrogen in an available form. The process is conducted in an electric furnace. (1,242,264, Oct. 9, 1917.)

Inorganic Chemicals and Miscellaneous Products

Phosphoric Acid.—WM. H. WAGGAMAN, HARRY BRYAN and C. R. WAGNER, Washington, D. C. (Patent dedicated to the public.) New apparatus for making phosphoric acid and its compounds. Consists of a blast furnace (Fig. 1), provided with an inner or charge chamber, *B*, surrounded by, but discharging in-

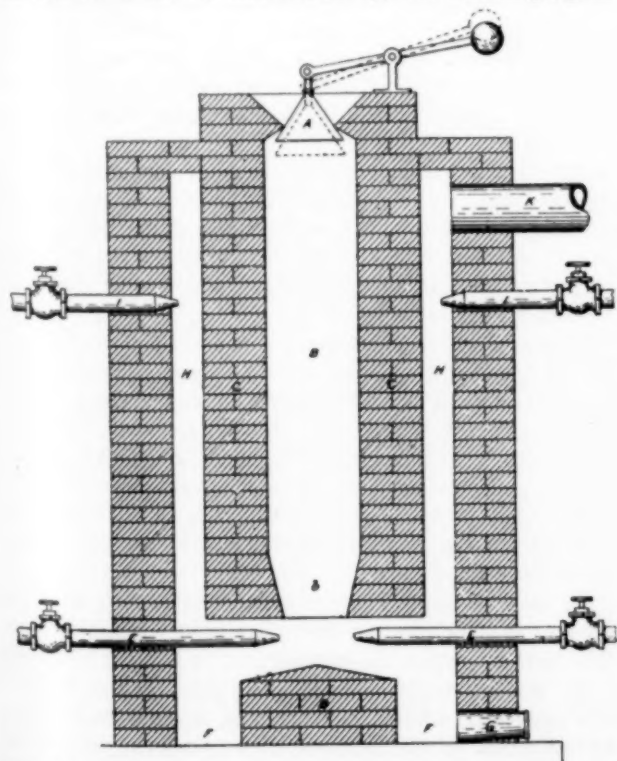


FIG. 1. BLAST FURNACE FOR PRODUCING PHOSPHORIC ACID

to, an outer chamber, a platform below the charge chamber for receiving the discharge from the same. Means is provided for introducing air into the outer chamber for introducing air into the outer chamber for burning and smelting the charge upon said platform and smelting the charge upon said platform. For introducing a further quantity of air into the upper part of the outer chamber in order to oxidize further the volatile products of the reactions the nozzles *I* are provided. Means for withdrawing the products of the reaction from the outer chamber is provided at *G*. (1,241,791, Oct. 2, 1917.)

Case-Hardening Material.—A. O. BLAICH, Chicago, Ill. Assigned to A. O. Blach Company, Chicago. Case-hardening material and process of making same, using ground charcoal or coke as starting point. This is forcibly submerged in a hot soda ash solution for a period of time and then dried in a revolving drum at 300 deg. Fahr. The mass is then sprayed with oil and mixed with calcium carbonate or barium carbonate. (1,241,909, Oct. 2, 1917.)

Aluminous Abrasive.—L. E. SAUNDERS and R. H. WHITE, Niagara Falls, N. Y. Assigned to The Norton Company, Worcester, Mass. An electric furnace product prepared by adding zirconia or certain of its compounds to bauxite or equivalent impure aluminous ores, the charge being then fused in the electric furnace and subsequently cooled either in the furnace or after removal therefrom. A small proportion of coke is added, sufficient to reduce the major portion of the iron oxide and silicon. No appreciable amount of zirconia is reduced. (1,240,491, Sept. 18, 1917.)

Organic Compounds

Phenol Condensation Products.—K. TARASSOFF and P. SHESTAKOFF of Petrograd, Russia, patent a process of obtaining solid condensation products of phenols, formaldehyde and salts of sulfo-acids. The chief claims are as follows:

"Process of producing solid, infusible and insoluble phenol-aldehyde condensation products, comprising bringing together a phenol, formaldehyde, a salt of an alkaline reacting base and of a sulfo acid obtained in the sulfonation of crude mineral oil and an acid weaker than the sulfo acid, heating the mixture to start the reaction, removing the water that separates out, heating the residue on a water bath until the loss of weight reaches 70-75 parts by weight of the total amount of the materials employed, cooling the mass to 35-40 deg. C., adding a further quantity of formaldehyde, pouring the mass into molds, allowing the mass to remain at rest for some hours and then gradually raising the temperature of the mass to 100 deg. C." (1,237,599, Aug. 21, 1917.)

Amino-Oxy-Compounds.—ALFRED PIQUET, E. STEINBUCH and R. STOCKER, of Basel, Switzerland, patent an electrolytic reduction process which is assigned to the Society of Chemical Industry in Basel. According to the process amino-oxy-compounds are made by electrolytic reduction of aromatic nitrocompounds in acid, by employing as electrolyte in the cathode chamber a diluted acid solution which contains not much more acid than is necessary to combine with the bases produced by the reduction and in conducting the electrolysis in presence of at least two metals in the cathode chamber, which by continuously passing into solution and depositing on the surface of the cathode, maintain the latter always coated with a deposit of at least two metals. (1,239,822, Sept. 11, 1917.)

A New Blast Furnace Gas-Cleaning Machine

By John Ruddiman

The constantly increasing demand for higher blast temperatures has met with fairly good success through the introduction of gas cleaning devices of various types and principles, which permit the use of stoves with greatly increased heating surfaces, resulting from smaller checker passages.

But even with the best means employed for cleaning the gas, there is still something lacking to bring about conditions which operators regard as "ideal." Clean gas they must have, and get.

Clean, dry gas they prefer, and get only when atmospheric conditions permit.

Clean, dry, hot gas is their "ideal," and can get if they will follow the process only one step further.

Advocates of the dry and the wet processes of gas cleaning are still threshing out the question of superiority, moisture being the bone of contention; but in the end all must agree that the cleanest, driest, hottest gas will furnish more B.t.u.'s at the tuyeres for a longer continuous period than will gas lacking in any one of these essentials.

The best of the dry processes, assuming that the dust content of the cleaned gas is satisfactorily reduced, furnishes gas retaining most of the sensible heat, and all the moisture it had on leaving the furnace. Because of the high temperature, it ignites at the burner in spite of the high moisture content, normally about 35 grains.

The best of the wet processes, while removing the dust to a satisfactory degree, furnishes gas cooled to near the temperature of the water, and usually super-saturated on leaving the cleaner. During its passage to the stoves a lower moisture content follows a drop in atmospheric temperature (the gas main acting as a condenser, requiring to be tapped and often cleaned), but the gas will still be at the saturation point on reaching the burners. Although of low moisture content (about 11 grains at 80 deg. Fahr.) the gas does not readily ignite, ignition usually taking place high up in the combustion chamber, hence a loss in heating surface in the stoves below the point of ignition which preheating of the gas would prevent. Preheating is not a new thought, but it has never been successfully applied in blast furnace practice. Recent developments in stove construction with the resulting high efficiency from small checkers prove that it can be economically applied. If two stoves with yet smaller checkers will accomplish better results than three, four or even five of the stoves in common use, and where the reduced temperatures of the waste gases will permit a suction fan to replace the draft stack, the saving in cost of construction would more than offset the cost of installing a preheating system.

By utilizing all the gas from the dust catcher for preheating the cleaned gas for the stoves, the reduced temperature of the uncleaned gas going to the cleaners will effect an economy in the water used for cooling purposes, while the portion of gas going to the boilers will still be of sufficient temperature to ignite at the burners without the use of coal, which is necessary when cleaned, cold gas is sent to the boilers.

The accompanying illustrations show two types of preheaters, either of which may be used in the layout shown, or connected up with any type of gas cleaners.

Type No. 1 in the layout is a combined heater and secondary dust catcher, and consists of a number of flues inclosed by two headers and part of the cylinder shell to form a heating chamber. This chamber is quarterly divided by vertical baffles arranged to form four connecting passages. A large central pipe, closed at the top by the header, and having an opening in its side at the top of the fourth passage, is connected by an elbow, below the bottom header, with a pipe horizontally carried through the dust chamber to a brick-lined stove main. The dust chamber is formed by the lower part of the cylinder shell, the conical bottom and bottom header. Two inverted elbows are attached to the cylinder near the top of the dust chamber; the large elbow, leading the twice dry-cleaned, hot gas to the boiler gas main; and the small elbow, leading the twice dry-cleaned, hot gas to the primary scrubber. Full details of the primary scrubber are not shown.

The apparatus comprises either a square or rectangular tank having a hopper bottom for holding the waste water and a semi-circular cover which incloses a gas chamber into which opens the gas inlet pipe at one end and the gas outlet pipe at the opposite end. Passing longitudinally through the tank is a shaft supported and driven from without the tank by any suitable means. Stuffing boxes are provided to prevent the escape of gas at the points at which the shaft pierces the wall of the tank. Upon the rectangular mid-portion of the shaft within the tank is arranged a series of circular perforated baffle plates. Nozzles are fitted into the holes of each baffle plate, except the last of the series, the sum of the area of the nozzles in each baffle being slightly in excess of twice the area of the gas inlet pipe.

The baffle plates are suitably spaced apart along the shaft and secured thereto by flanges bolted to each baffle and having hubs, with set screws or keys, which serve to space the baffles apart. The baffles are supported in a vertical position and parallel to each other by ferrules on bolts which pass through the series of baffles at a convenient radial distance from the shaft and bind the baffles together when the nuts are set up.

The baffles have their nozzles so arranged that those of one baffle discharge against the blank interspaces on the following baffle so that the gas issuing from the nozzles in fairly close proximity to the adjacent baffles is brought into intimate contact with the blank spaces of the latter.

Spray pipes are arranged between the baffles and at the inlet and outlet ends of the gas chamber. The latter are designed to throw a spray upon the wall of the gas chamber to clean the latter, while the pipes between the baffles are so arranged that their jets are discharged against the adjacent faces of juxtaposed baffles and into the nozzles thereof, so that both the surfaces of the baffles and the interior of the nozzles are cleaned.

In this apparatus is combined the principle of the contact type of cleaner with that of the scrubber type. It is self-cleaning and economical in the use of water.

At the ends of the tank internal overflow troughs are provided, which maintain the normal water level of the water in the tank slightly below the center line of the shaft. A water seal is provided by waste pipes

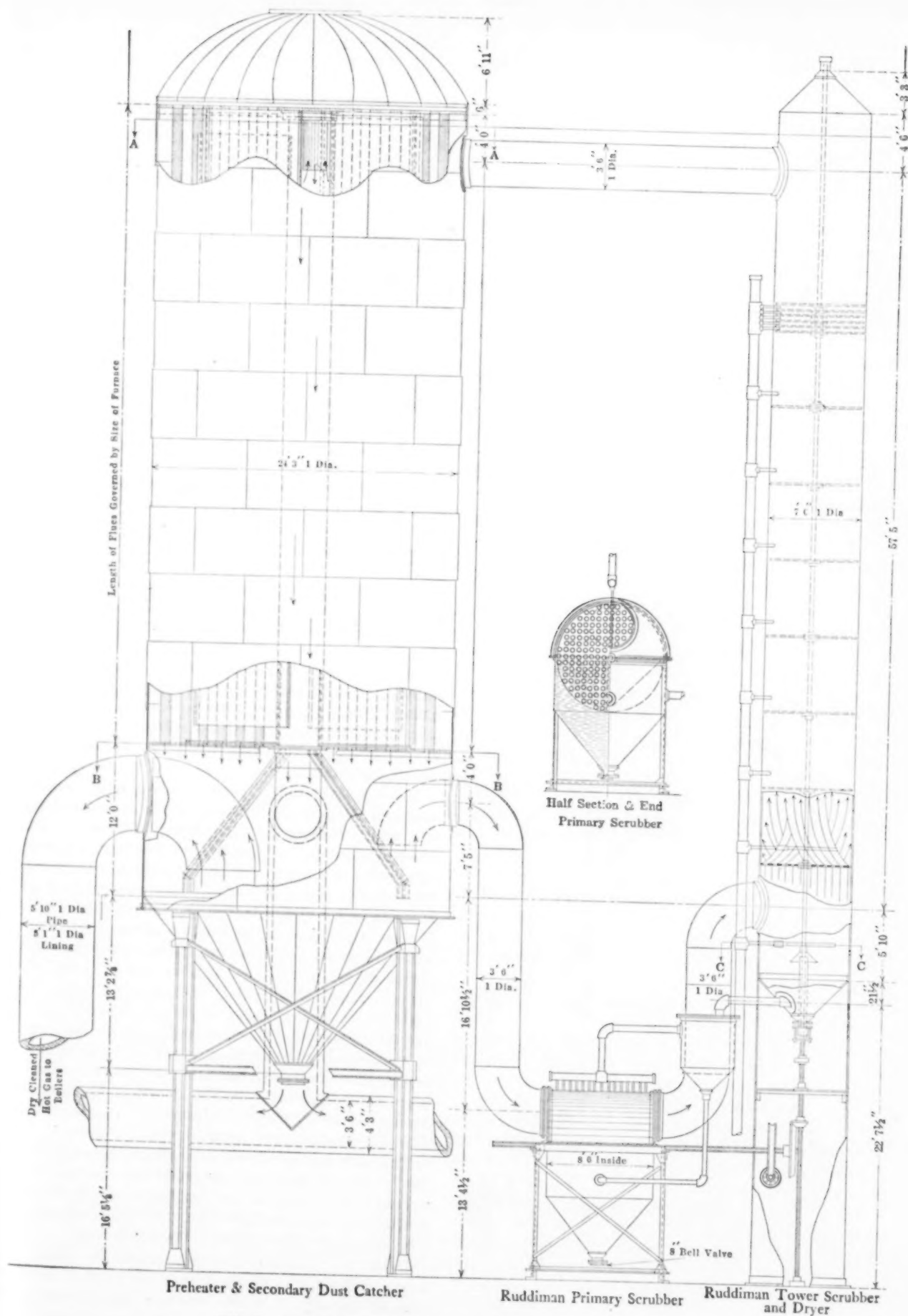


FIG. 1. COMBINED HEATER AND SECONDARY DUST CATCHER

connected with the overflow troughs and maintains the water level in the latter lower than that of the water in the tank.

The cooling tower comprises a vertical cylindrical vessel having a conical top with a shaft bearing at the apex, and a conical bottom having a stuffing box at the apex to form a gas chamber having an inlet and an outlet pipe. In lieu of columns the cylinder is extended to the ground level to form a dust-tight inclosure for the operating mechanism.

A vertical shaft is centrally extended from a thrust bearing at the ground level through the gas chamber to a bearing at the top. On the shaft are arranged, at suitable distances, a number of circular perforated baffle plates. Above these, arranged in series, are circular perforated baffle plates fitted with nozzles

similar to, and arranged on the shaft in the same manner as those in the primary scrubber.

Spray pipes are arranged to produce showers of water between the baffles. A sleeve is attached to the stuffing box casting and encircles the shaft for a suitable distance; slightly above it is an umbrella attached to the shaft, both combining to protect the shaft from dirt collecting at the bottom of the cone.

The scrubber and cooling tower shafts are connected up to take power from the same driver.

In operation the highly heated gas from the dust catcher passes through the flues of the heater at a greatly reduced velocity, its temperature considerably lowered by radiation. Entering the dust chamber over a large area (see arrows) the velocity of the gas is reduced to about 170 ft. per minute (at 400 deg. Fahr.), thereby releasing a high percentage of dust. The twice dry-cleaned gas then passes, via the inverted elbows, to the primary scrubber and the boilers in about the proportion of one-third and two-thirds respectively. The portion of gas passing to the primary scrubber is broken up into a large number of small jets by its passage through the nozzles; a portion of the dust is deposited on the wet surface of the first baffle. Passing through the nozzles of the first baffle the gas jets impinge on the wet blank surfaces of the second baffle, which surfaces are directly opposite the nozzles. The velocity of the gas passing through the nozzles is practically undiminished, since the sum of the areas of the nozzles above the water level is but slightly greater than the area of the inlet pipe. Dust is deposited on each baffle in succession in this way, the process being repeated as many times as desired and being determined by the number of baffle plates used. Spray pipes between the baffles furnish cooling water in finely divided form, thereby further increasing the efficiency of the cleaner by scrubbing and cooling the gases as they pass between the baffles.

The dust deposited upon the baffles is constantly removed by their rotary passage through the water in the tank, so that they constantly present a freshly washed surface for the gas to impinge against and the baffles are kept cool and wet during their transit through the gas chamber (at 20 r.p.m. no part of the baffle is in contact with the gas longer than $1\frac{1}{2}$ sec.). The nozzles have a bucket-like effect in lifting the water into the gas chamber, thus aiding in cleaning and cooling the gas as well as the surfaces of the baffle plates. The water in the tank is constantly agitated by the passage of the baffles therethrough and this prevents the accumulation of floating dirt at the water level which might tend to adhere to the baffle plates and prevent their efficient operation. The scum is carried off with the overflow by drain pipes connected with troughs arranged at the ends and inside the tank at the water level.

The water is admitted to the tank below the water level, and to the gas chamber through pipes connected with a settling tank arranged above the scrubber to receive the waste water from the cooling tower. The supply is thus made to do double duty.

From the scrubber the gas passes to the cooling tower, where it is brought in close contact with successive showers of water between the perforated baffles. Channeling is prevented by the perforations and

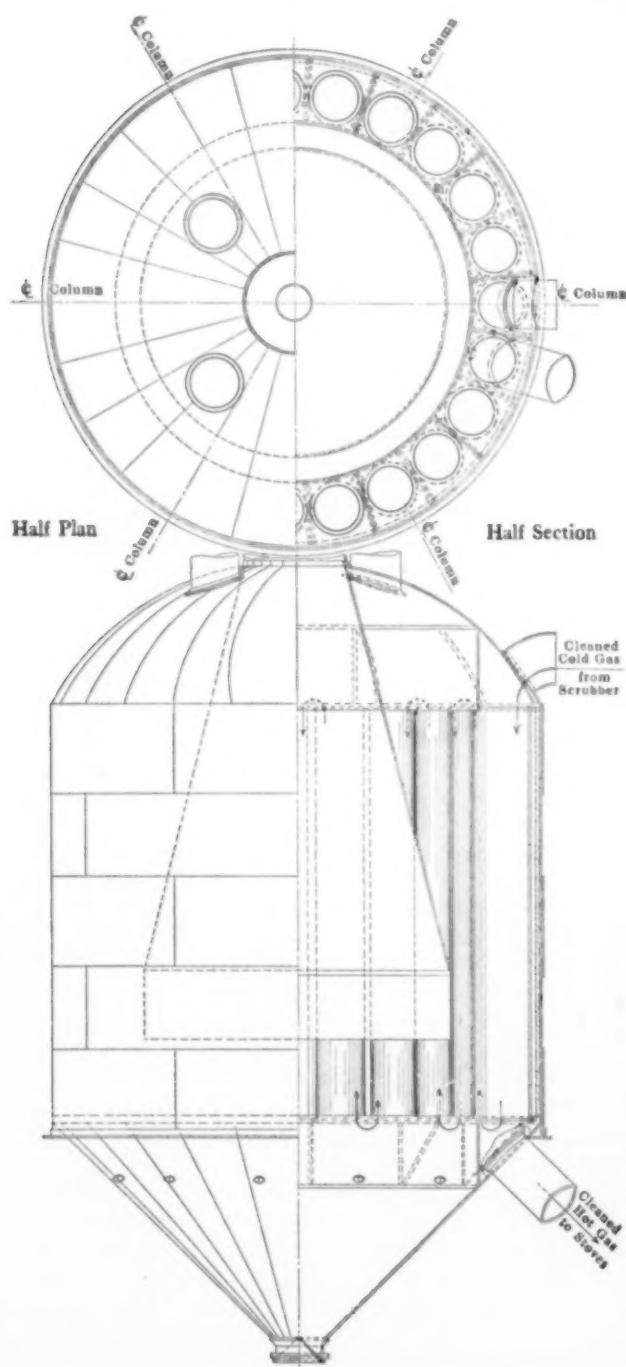


FIG. 2. COMBINED PRIMARY DUST CATCHER AND HEATER

the spiral-like motion created by the revolving baffles. Cleaned, cooled but wet, the gas then passes through the series of baffles with nozzles. Its velocity is accelerated in passing through the nozzles, causing the mechanically carried moisture to be deposited on the baffles in like manner performed in the scrubber. The water and dirt deposited on all the baffles will be thrown to the walls of the cylinder by centrifugal force and washed down between the cylinder and the periphery of the baffles to the drain pipe leading to the gas-tight settling tank, whence the water flows to the scrubber for second service.

The cooling tower is self-cleaning. Leaving the cooling tower the clean, dry, cold gas enters the first pass in the heating chamber where it expands and moves slowly down, entering the second pass at the bottom, thence up and down and up through the second, third and fourth passes respectively, gathering in transit the radiated heat from the hot gases passing down through the flues. On reaching the top of the fourth pass it enters the central pipe and gathers more heat from the elbow and pipe in the dust chamber. The clean, dry, hot gas now passes to the brick-lined stove main ready to ignite on reaching the burners.

The pipe connecting the cooling tower and the heater should be insulated to prevent condensation during cold weather.

Fig. 2 of the illustrations shows another method of preheating the cleaned gas, wherein the primary dust catcher and heater are combined in one vessel.

It consists of the usual form of dust catcher, but of ample dimensions to permit a series of large pipes to be circuitously arranged inside the cylinder shell for the passage of the cleaned gas. In lieu of return or U bends to form a continuous passage through the series of pipes, chambers at the upper and lower ends of the pipes are formed by header plates attached to the cylinder shell and to rings attached to the dome and bottom cone, with baffles spaced to connect the pipes for continuous passage. The chambers serve to economize space and to mix the gas currents of different degrees of temperature to produce a uniform temperature at the outlet pipe. The bottom chambers are provided with hand holes for cleaning if necessary.

The passage of gas is shown by the arrows. As the ratio of the gas passing through the dust catcher to that passing through the heating pipes is nearly 5 to 1, the temperature of the cleaned gas will be raised far above its initial temperature, and ignite at the stove burners.

A funnel-shaped extension of the down-comer pipe directs the gas toward the heating pipes. Attached to it is a ring of suitable width to divert the heavier materials, during a slip, from the ring forming the gas chambers arranged around the base of the cone bottom.

Four outlets are provided in the dome to prevent channelling. One will be connected with the scrubber, and three to merge into one pipe leading to the boilers.

As the dust catcher is of large diameter the flow of gas will be very slow, based on 45,000 cu. ft. gas per minute, and at 400 deg. Fahr. T. T. it will be about 220 ft. per minute leaving the funnel, and about 120 ft. per minute for the up-flow. Under these con-

ditions the gas would be much cleaner than that from the usual dust catcher and perhaps sufficiently clean for the boilers. But if further cleaning is desired it would better be run through a Mullen gas washer, since the sensible heat will be retained and the expense of operation is practically nil.

The cylinder shell of the dust catcher has a 4½-in. brick lining.

The size of both types of heaters is based on 45,000 cu. ft. gas per minute, 30,000 cu. ft. for the boilers and 15,000 cu. ft. for the stoves.

229 Front St.,
New York City.

A Modified Aluminum Welding Process

A new aluminum solder for which excellent results are claimed has been developed and placed on the market by the Alumunite Manufacturing Co., of 427 Fourth Avenue, New York City. It is intended as a substitute for the electric and acetylene-welding processes, and the undesirable features of many aluminum solders are stated to have been overcome. Lessened cost and simplicity of application are also claimed. Also the absence of high temperatures as alumunite requires only 350 deg. Fahr.

It contains no lead or antimony; the main ingredients being aluminum, tin and zinc, and its tensile strength on lap and butt joints is from 8500 to 12,500 lb. per sq. in. Repairs are stated to remain permanent and not to disintegrate.

American Made Pyrometer Protection Tubes

After a long period of experimentation in the production of porcelain pyrometer protection tubes, Charles Engelhard, 30 Church St., New York, has developed a ware to take the place of the formerly imported Marquardt porcelain. The ware is called Impervite and a description of it is given as follows by the manufacturer:

The body of the two tubes, i.e., Impervite and Marquardt, is practically identical, having almost exactly the same coefficient of expansion, the same mechanical strength, the same porosity, and both absolutely without effect upon platinum wire under high temperatures. The fusing point of the body has not been accurately determined, but it is above 3500 deg. F.

The glaze of the Impervite tube is of a different nature than Marquardt, being harder after it is matured, and having a softening point more than 100 deg. C. above the softening point of the Marquardt glaze. This glaze is thoroughly impervious when uniformly applied, and strongly resistant to fluxing action. It possesses a further decided advantage in that it does not become as sticky at high temperatures above its softening point, as does the Marquardt glaze, as a result of which it does not so readily adhere to an outside protecting tube when heated above the softening point, and then allowed to cool below the softening point.

The body and glaze as used in Impervite tubes, lend themselves to other porcelain ware.

Not only the accuracy, but the life of the thermocouples very much depends upon the ability of the protecting tubes to exclude all gases, and to stand up both physically and mechanically under the furnace conditions in which they are installed.

It is now becoming common practice not only to protect thermo-couples of the platinum-rhodium and platinum-iridium group with this type of tube, but also the thermo-couples known as "base metal" thermo-couples, it having been found that the accuracy and life of base metal thermo-couples, when so protected, are very materially improved.

Book Reviews

Empirical Formulas. By Theodore R. Running. Octavo (15 x 22.5 cm.), 146 pages, 52 diagrams. Price, \$1.40 net. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Limited.

This volume is No. 19 of the Mathematical Monographs edited by Mansfield Merriman and Robert S. Woodward. It is intended to assist engineers to find formulas to fit their observations, so as to facilitate engineering calculations and to get exact interpolations. The first five chapters deal with simple tests to be applied to a set of data to determine if they can be represented by certain simple types of equations; another chapter deals with the method of least squares; another with formulas for interpolation; another with approximate formulas for areas, volumes, moments of inertia, etc. The idea throughout is to help the engineer to simple working formulas representing his data, rather than any exact development of formulas representing natural laws. Every experimental and practicing engineer may find help in such a discussion. The treatment is sufficiently elementary to be within the capabilities of anyone who can use the calculus.

* * *

Evaporating, Condensing and Cooling Apparatus. By E. Hausbrand. Second English edition, translated from the second revised German edition by A. C. Wright, B.Sc. Octavo (22 x 14 cm.), xxiii+, 401 pages, 21 illustrations. Price \$5 (12/6) net. London: Scott, Greenwood & Son.

An engineering compendium covering the quantitative calculation of the constants and efficiency of such apparatus. Although a little ponderous, and going into unnecessarily minute detail at places, yet it is thorough, clear and conscientious. The treatment is on the basic laws of physics, and is largely mathematical. There is a minimum of merely descriptive matter. The only defect is that the translators did not introduce some more recent data on heat transmission, radiation, etc., which has appeared since the German edition was revised, sixteen years ago. Numerous calculated-out examples give relief to the theoretical treatment and render the work very practical and easy to apply. It is a good whetstone for chemical and mechanical engineers to sharpen their wits upon.

* * *

The Principles of Iron Founding. By Dr. Richard Moldenke. Octavo (15 x 23 cm.), x + 517 pages, 45 illustrations; price \$4.00 net. New York, McGraw-Hill Book Company, Inc.; London, Hill Publishing Company, Ltd.

This is a true compendium of a life-time experience. The author, the genial and indefatigable secretary of the American Foundrymen's Association for many years, is here at his best. He narrates his experiences and systematically courses through his subject matter from planning the foundry to selling its products as

if performing a labor of love and without writing a dull or a dry paragraph. Strictly speaking, it is more human and intuitive than accurately scientific, but the latter quality can be left to those other writers who are always accurate and never interesting. By an unfortunate slip, the data given on the thermo-physics of iron on pages 109 to 112, are the B.t.u. per kilogram and not per pound; they need to be divided by 2.2 to be correct. This is but a small blemish, however, on a very readable and valuable book.

* * *

Analysis of Copper. By George L. Heath. 292 pages. Price \$3.00. New York: McGraw-Hill Book Company, Inc.

This book very acceptably fills its place among others for use in industrial laboratories. The methods given are those of which industrial practice has fully demonstrated the merit. Unnecessary details have been omitted though sufficient guidance is given in the several schemes.

Exception might be taken to the author's conclusion concerning the reliability of the scheme for arsenic and antimony there given. Any scheme that is accurate must be reliable; and in this particular instance experience has shown that the scheme is as reliable as it is accurate, presuming that the directions given are closely followed. This latter is true of any analytical scheme.

Mention might well have been made of the use of gauze cathodes in the assay of copper by electrolysis. By their use the length of time of deposition is materially shortened and the use of mechanical stirrers is obviated; for by using an increased current in conjunction with the gauze cathode sufficient agitation of the solution is obtained by the more rapid evolution of gas from the electrolyte.

The practical usage of a book of this nature is determined largely by its indexing. In this case the author has done his work well and the various schemes are thus rendered more accessible to the chemist who is following the methods.

Personal

Mr. Frank Wharton Brooke, formerly metallurgist of Crowleys, Detroit, and at the Ludlam Steel Works, and Mr. G. W. Ketter, who has just finished the erecting and installation of ten 6-ton furnaces at the British Forgings, Ltd., Toronto, Ont., have joined the staff of the Electric Furnace Construction Co. at Philadelphia.

Mr. Charles F. Hall, formerly structural and mechanical engineer of Armour & Co., has joined the staff of the Booth-Hall Co., 565 West Washington Street, Chicago, Ill., manufacturers of electric steel furnaces, in the capacity of production manager.

Mr. Allen Hoffer, superintendent of the blast furnaces for Worth Brothers Company, Coatesville, Pa., has resigned, effective Nov. 15, to become associated with the Cliffs Iron Company, Cleveland, Ohio, in the capacity of superintendent.

Mr. Richard K. Meade, consulting chemical and industrial engineer, of Baltimore, Md., announces that he has formed a partnership with Mr. Howard C. Tompkins, one of his associates, under the name of

Richard K. Meade & Co. Mr. Tompkins is a graduate of Cornell University (1903) with the degree of civil engineer and has had many years' experience in the design and construction of cement, lime, plaster and chemical plants; in steel and reinforced concrete work and in general industrial engineering.

Mr. R. J. Morgan, formerly with the Midvale Steel and Ordnance Company, has been appointed supervisor of sales of the American Steel Export Company, New York. Mr. Morgan prior to his connections with the Midvale Steel & Ordnance Company, spent thirteen years with the Carnegie Steel Company.

Prof. Horace B. Patton, who served a period of twenty-four years as professor of geology and mineralogy at the Colorado School of Mines, announces that he has opened an office at Golden, Col., for the practice of his profession as consulting and field geologist. Special attention will be paid to oil and gas and to metalliferous deposits.

Mr. W. O. Renkin, who for some years past has been chief engineer with the A. M. Byers Company of Pittsburgh, has resigned from that company to act in the capacity of manager of the engineering department of the Quigley Furnace Specialties Company, 26 Cortlandt Street, New York, N. Y., who specialize in powdered coal installations. Previous to going with the A. M. Byers Company Mr. Renkin spent some years as resident engineer in charge of the organization and construction of the works and town of Sakchi, Bengal, India, for the Tata Iron & Steel Company.

Of the members of the instructing staff of the department of chemistry at the Massachusetts Institute of Technology, Professors W. H. Walker and J. F. Norris, Dr. F. H. Smyth and Mr. R. E. Wilson are on leave of absence, and Prof. W. K. Lewis devotes only part of his time to the institute during the present year. All these men are actively engaged on gas-defense problems, and are holding responsible positions in the organization which is dealing with these problems at Washington and elsewhere. Prof. A. A. Noyes spends a part of his time at Washington, in connection with the work of the National Research Council and the Nitrate Committee. Professors Mulliken, Spear and Mueller have also been engaged at the institute on investigations relating to gas-defense. Professors F. J. Moore and H. P. Talbot gave, during a portion of the summer courses of instruction to students who were expecting to apply for commissions in the Reserve Officers' Training Corps.

CURRENT MARKET REPORTS

The Iron and Steel Market

A third batch of set prices was announced at Washington, Nov. 5, practically completing the price fixing for the iron and steel producing industry. Summarizing, the set prices, with the dates of announcement, are as follows:

Sept. 24: Lake Superior iron ore, the 1917 schedule, subject to readjustment in the event of the Lake rate departing from \$1, making Mesabi non-Bessemer at Lake Erie dock \$5.05; pig iron, \$33 for basic and foundry; bars, 2.90c.; shapes, 3c.; plates, 3.25c.

Oct. 11: Billets, 4 x 4 and larger, \$47.50; small billets, \$51; slabs, \$50; wire rods, \$57; grooved skelp,

2.90c.; universal, 3.15c.; sheared, 3.25c.; shell steel rounds gothic billets, etc., 3 to 5-in., 3.25c.; up 5-in., 3.50c.; to 10-in., 3.75c.; over 10-in., 4c.

Nov. 5: Sheets, black, 28 gage, 5c.; blue annealed, 10 gage, 4.25c.; galvanized, 28 gage, 6.25c.; tin plate, \$7.25 for 100-lb. cokes; pipe, 51 per cent card basing discount, equal to 52, 5 and 2½ off list on ¾ to 3-in.; plain wire, 3.25c.

With the co-operation of the American Iron and Steel Institute, using committees of substantially the same personnel as resigned as subsidiary to the Advisory Commission on account of the menace of the Pomerene amendment to the Lever act, details, differentials, etc., are being worked out. Pig iron is set at \$33 f.o.b. furnace, all districts, for No. 2 foundry and basic, malleable at \$33.50, Bessemer at \$36.30, low phosphorus, copper-bearing, \$50; no copper, \$53. No. 2 foundry is 1.75 to 2.25 per cent silicon.

Billets, sheet bars and slabs are f.o.b. Pittsburgh or Youngstown. Rods, shell steel and skelp are f.o.b. Pittsburgh, and wire, sheets, tin plates and pipe will probably be the same. Merchant bars, shapes and plates are f.o.b. Pittsburgh or Chicago, this being quite an innovation.

The furnace-coke price was set at \$6 by President Wilson, the price being announced Sept. 24. This was under authority of the Lever act, despite the quibble of a few coke operators to the contrary.

All the prices are on the principle of "one price for all," the Government, its Allies, and the general public. This means that the producers make such sales of war material as the Government desires them to make, while as to the public they sell at will; but if they sell, at not above the set prices.

Producers are carrying out the agreement, for it is an agreement, except in the case of coke, in spirit as well as in letter. They do not sell to the public when they cannot make the deliveries desired, and in the main they are indisposed to make sales for far forward delivery, using as one reason the proviso of the Government that the set prices are subject to revision Jan. 1 or later. Producers are endeavoring, as usual, to take care of regular customers, and are as a rule, indisposed to sell to chance buyers not regular customers, one reason being that the inquirer may have a contract with another producer at a price higher than the set price.

In the case of pig iron there has been a broader market, with more activity than for weeks preceding the price setting. For instance, Messrs. W. P. Snyder & Company have for years compiled monthly a Bessemer and a basic pig-iron average, weighted according to tonnages 1000 tons and over, of all valley iron sold. The computation for October shows precisely the set prices, \$36.30 for Bessemer and \$33 for basic, and the tonnage entering the computations was fully 100,000 tons, or more than in any of the three months preceding. This showing indicates a willingness on the part of producers to transact business, and does not indicate that pig iron is not scarce, for it is as scarce, physically, as it was. There is not enough pig iron to operate all the steel-making facilities at capacity, capacity being estimated at 49,000,000 tons of ingots, with 5,000,000 tons under construction, and production 44,000,000 tons.

In unfinished steel the market movement is very light, there being merely occasional sales of odd lots arising in course of mill operation.

In finished steel products there is a light movement, but there is more or less trading in all commodities.

OPEN MARKET AND SET MARKET

The transition from an open market into the set market occurred quite differently in the various products. In bars, shapes and plates a great drop was represented in the act of price setting, particularly as the open market existing had been made upon relatively early deliveries at what would be "premiums" if there had been a well-defined market for late deliveries, which was not the case. In billets, which had reached \$95 to \$100 in June, there was a very narrow market for a few weeks preceding the price fixing, with occasional offerings at lower and lower prices down to \$60. In wire there had been the anomaly of the American Steel & Wire Company adhering to its prices first made last March, based on \$3.20 for nails, while the independents had advanced to \$3.40 and then to \$4. Just prior to the price announcement the American company had advanced its prices from 3.15c. to 3.25c. on plain wire and from \$3.20 to \$3.50 on nails. The National Tube Company and Republic Iron & Steel Company occupied the unique position that with respect to pipe their official prices were below those set by the Government. They were adhering to their 55 per cent list of April 2, allotting their tonnage to regular customers while other mills had advanced May 1 to a 49 per cent list, and La Belle, Wheeling Steel & Iron, and Jones & Laughlin had advanced under date of June 25 to a 42 per cent list, and one that carried advances generally of 10 to 15 points on sizes other than base. Thus the 51 per cent prescribed list represented an advance for two producers and declines for others. The set price is regarded as too low for detached mills, if they must pay the set prices for skelp, and skelp mills may make concessions to regular customers.

Except for plates, sheets had scored the greatest advance, reaching 8c. to 9c. in June, and holding that level fairly well until early in October. Then a decline began, developing into a break. The set prices were given to the newspapers on the evening of Nov. 5, becoming known to the trade the next morning. A week before some sheets were available at 5.50c., if not at 5.25c., while on Nov. 5 there were some exceptional offerings of black sheets at 5c., the price just to be announced. The sheet mills had driven the situation too hard a few months earlier, and some of them were almost bare of orders.

PRODUCTION AND CONSUMPTION

Based on a 44,000,000-ton ingot rate, finished rolled steel is being produced at the rate of about 33,000,000 tons. Last year's production was 30,500,000 tons, direct and indirect exports leaving close to 24,000,000 tons for purely domestic consumption. The total war requirements are variously estimated at 10,000,000 to 15,000,000 tons, the uncertainty being not as to what it would be well to consume, but as to the fabricating or manufacturing capacity that can be marshaled to convert steel mills products into ships, munitions, etc., and as to the rolling capacity for certain products, par-

ticularly plates. Presumably there will be practically no exports to neutrals unless all other requirements are satisfied. There may be left for ordinary domestic consumption almost as much steel as was absorbed in 1916, while it is a question, at any rate unless the railroads can become liberal buyers, whether so much steel can be absorbed in a commercial way when the country is at war. The desire to consume may be reduced, and likewise the ability to consume, through labor shortage, lack of adequate transportation facilities, and shortage of certain descriptions of rolled steel, as well as other raw materials.

Non-Ferrous Metal Market

Friday, Nov. 9.—The markets have been quiet. Copper is unchanged at the price fixed by the Government. Tin is scarce and considerably higher. Lead has advanced and the market appears strong. Spelter is weak and lower. Antimony has also declined. Silver is slightly higher.

Copper.—The general prevailing belief that sales of copper should not be made at higher than 23.50 cents is stopping considerable business and causing considerable copper to be held which might be offered for resale and which in some quarters is badly needed. Holders cannot afford to sell at 23.50 cents copper which they purchased at a higher price.

Tin.—Straits tin is nominally quoted at 70.00 cents spot. Some Banca tin and English Lamb & Flagg has been offered at 66.50. There is a considerable shortage of tin in this country, and while the statistics show no real shortage throughout the world, the stocks in this country are low owing to the stringent shipping situation.

Lead.—Lead was advanced on Nov. 7 by the trust from 6.00 to 6.25 cents. Good business is reported lately from both Government and private interests and the market is strong. Independents are asking 6.25-6.50 spot. Futures up to December are no lower.

Spelter.—Little interest has been shown and the market is weak. Prompt spelter is quoted at 7.67½ New York and up to 7.80 for futures. The Government will require enormous quantities of high-grade spelter for shells, estimated at 100,000,000 lb. per year, and this quantity is liable to increase. The price on this material may be fixed by the Government.

OTHER METALS

Antimony, Chinese and Japanese, pound.....	0.13%	—0.14
Aluminum, No. 1 Virgin, 98-99 per cent, pound.....	0.36	—0.38
Magnesium, metallic, pound.....	2.60	—2.50
Nickel, electrolytic, pound.....		.55
Cobalt, pound.....		2.70
Cadmium, pound.....		1.50
Quicksilver, flask, California.....		100.00
Silver, ounce.....		86½
Platinum, pure, ounce.....		105.00
Palladium, ounce.....		115.00

Chemical Market

Coal Tar Products.—The general position of these markets shows somewhat of an improvement over the past few weeks. Phenol, toluol and naphthaline look particularly strong, and difficulty is generally experienced in locating real offers.

Benzol.—No material improvement in this market is noted and supplies exceed the demand owing to the fact that the export movement is more or less suspended.

Beta Naphthol.—A fairly steady demand is noted for small and moderate quantities and it is thought probable that a general demand for large lots would result in a material advance in this market. There are, however, only a limited number of producers in this field.

Aniline Oil.—This product is one which requires a license for export, and in consequence does not show any marked improvement. Stocks are rather large in some quarters and the situation is rather disappointing from a manufacturing viewpoint.

Benzoate of Soda.—A very firm situation exists and the demand for this product exceeds the supply.

Toluol.—The general demand has improved considerably, but supplies continue scarce, however, the greater part of the production is going into the manufacture of explosives.

Naphthalene.—A rather firm market continues to prevail, stocks, however, are light and difficult to obtain while manufacturers are not inclined to quote for future delivery.

Phenol.—This production has been well sold up over the first half of the coming year, and it is noted that the market is becoming exceedingly strong due to the difficulty in securing the material.

Dinitrophenol.—A better request for this product has been noted for a while past, and prices asked seem to be firmer.

Metanitrilaniline.—This product is being made by a few manufacturers, and at present spot supplies do not appear to be available.

Monochlorbenzol.—Supplies of this material seem to be quite ample; however, there does not appear to be much movement into consuming channels.

Heavy Chemicals.—There is an extreme quietness noted in the chemical market and somewhat of a reduction in all products which come under this heading is noticeable. These conditions are no doubt attributable to the difficulties experienced in securing permits for export.

Caustic Soda.—This market was practically neglected but during the past few days a rather persistent inquiry occurred. This resulted in the forming of prices, and buyers found very little real material offered. As 1918 approaches, the price is growing firmer and the firms in a position to quote are holding to high prices.

Soda Ash.—There has been a pronounced flurry in soda ash during the two weeks under review and the market has been subject to material recovery. Offers of real material are much restricted, particularly shipment from the works, which are not selling at a very high figure.

Bleaching Powder.—Bleach continues neglected and prices seem to be at a low level. No transactions of any importance have been noted for some time past.

Cyanides.—The position of this market has firmed up somewhat over the past week, although stocks are quite scarce and but little are available.

Bichromate of Soda.—Prices named for this product are at rather a low level, and tendency to decline is noted.

Bichromate of Potash.—Very little change is noted in the past few weeks, and, if anything, prices are not quite as firm.

Saccharine.—A decidedly upward turn is noted in this market, and considerable material is said to have changed hands for export.

Chlorates.—There is very little change noted in this situation either in the potash or soda, and prices range about the same.

Copper Sulphate.—A very firm and steady market is noted and most producers are quoting at the higher level.

Acids.—The acid situation continues stronger than ever, and prices for all grades have advanced particularly for nitric, muriatic and sulphuric acids. Oleum is very scarce, and at present difficult to obtain. The present high freight rates and cost of laid-down sulphur ore brings the cost of pyrites almost up to the value of brimstone acid. In consequence of this there is very little difference between brimstone and pyrites prices at the present time.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET, NOV. 8, 1917

Acetic anhydride.....	lb.	1.90	—	2.00
Acetone, drums.....	lb.	.36	—	.37
Acid, acetic, 28 per cent.....	lb.	.06	—	.06 1/2
Acetic, 56 per cent.....	lb.	.11 1/4	—	.12 1/4
Acetic, glacial, 99 1/2 per cent, carboys.....	lb.	.36 1/2	—	.37
Boric, crystals.....	lb.	.13	—	.13 1/4
Citric, crystals.....	lb.	.71	—	.72
Hydrochloric, C.P.....	lb.	.08	—	.08 1/4
Hydrochloric, 20 deg.....	lb.	.02 1/4	—	.02 1/2
Hydrochloric, C.P., conc., 22 deg.....	lb.	.02 1/4	—	.02 1/2
Hydrofluoric, 30 per cent, in barrels.....	lb.	.06 1/4	—	.06 1/2
Lactic, 44 per cent.....	lb.	.15 1/4	—	.16 1/4
Lactic, 22 per cent.....	lb.	.06 1/4	—	.06 1/2
Nitric, 36 deg.....	lb.	.07 1/4	—	.07 1/2
Nitric, 42 deg.....	lb.	.09 1/4	—	.10
Oxalic, crystals.....	lb.	.45	—	.46
Phosphoric, 47 per cent-50 per cent.....	lb.	.07 1/4	—	.08
Picric.....	lb.	.75	—	.85
Pyrogallol, resublimed.....	lb.	3.00	—	3.10
Sulphuric, 60 deg.....	ton	25.00	—	30.00
Sulphuric, 66 deg.....	ton	36.00	—	40.00
Sulphuric, oleum (Fuming), tank cars.....	ton	50.00	—	55.00
Tannic, U. S. P., bulk.....	lb.	1.25	—	.70
Tartaric, crystals.....	lb.	.77	—	.80
Tungstic, per lb. of W.....	lb.	1.80	—	1.90
Alcohol, sugar cane, 188 proof.....	gal.	5.20	—	5.40
Alcohol, wood, 95 per cent.....	gal.	1.20	—	.86
Alcohol, denatured, 180 proof.....	gal.	.84	—	.82
Alum, ammonium lump.....	lb.	.04	—	.04 1/4
Alum, chrome ammonium.....	lb.	.18	—	.19
Alum, chrome potassium.....	lb.	.24	—	.25
Alum, chrome sodium.....	lb.	.12 1/4	—	.13
Alum, potash lump.....	lb.	.08 1/4	—	.09
Aluminium sulphate, technical.....	lb.	.02 1/4	—	.03 1/4
Aluminium sulphate, iron free.....	lb.	.03 1/4	—	.04
Ammonia aqua, 26 deg. carboys.....	lb.	.16 1/4	—	.17
Ammonium carbonate.....	lb.	.11 1/4	—	.12 1/4
Ammonium nitrate.....	lb.	.20	—	.22
Ammonium, sulphate domestic.....	lb.	.07 1/4	—	.08
Amyl acetate.....	gal.	5.25	—	5.40
Arsenic, white.....	lb.	.16	—	.16 1/4
Arsenic, red.....	lb.	.65	—	.70
Barium carbonate, 99 per cent.....	ton	70.00	—	70.00
Barium carbonate 97-98 per cent.....	ton	65.00	—	67.00
Barium chloride.....	ton	70.00	—	80.00
Barium sulphate (Blanc Fixe, powder).....	lb.	.03 1/4	—	.05
Barium nitrate.....	lb.	.08 1/4	—	.11 1/4
Barium peroxide, basis 70 per cent.....	lb.	.27 1/4	—	.27 1/4
Bleaching powder, 35 per cent chlorine.....	lb.	.01 1/4	—	.01 1/4
Borax, crystals, sacks.....	lb.	.07 1/4	—	.07 1/4
Brimstone, crude.....	ton	60.00	—	65.00
Bromine, technical.....	lb.	.65	—	.70
Calcium, acetate, crude.....	lb.	.06	—	.06 1/4
Calcium, carbide.....	lb.	.08 1/4	—	.09
Calcium chloride, 70-75 per cent, fused, lump.....	ton	36.00	—	38.00
Calcium peroxide.....	lb.	1.60	—	1.70
Calcium phosphate.....	lb.	.30	—	.31
Calcium sulphate.....	lb.	.07	—	.07 1/4
Carbon bisulphide.....	lb.	.16	—	.16 1/4
Carbon tetrachloride, drums.....	lb.	.82 1/4	—	.85
Caustic potash, 88-92 per cent.....	lb.	.08 1/4	—	.08 1/4
Caustic soda, 76 per cent.....	lb.	.15	—	.18
Chlorine, liquid.....	lb.	1.40	—	1.50
Cobalt oxide.....	lb.	.01 1/4	—	.01 1/4
Copperas.....	lb.	.30	—	.30
Copper carbonate.....	lb.	.75	—	.78
Copper cyanide.....	lb.	.0965	—	.0975
Copper sulphate, 99 per cent, large crystals.....	lb.	.55	—	.60
Cream of tartar, crystals.....	lb.	.03 1/4	—	.04
Epsom salt, bags.....	lb.	.17 1/4	—	.18
Formaldehyde, 40 per cent.....	lb.	.80	—	.80
Glauber's salt.....	100 lb.	.70	—	.71
Glycerine, bulk, C. P.....	lb.	3.50	—	3.55
Iodine, resublimed.....	lb.	.13	—	.15
Iron oxide.....	lb.	.17 1/4	—	.19
Lead, acetate, white crystals.....	lb.	.16	—	.19
Lead arsenate.....	lb.	.17 1/4	—	.18
Lead nitrate.....	lb.	.09 1/4	—	.11 1/4
Litharge, American.....	lb.	1.50	—	2.00
Lithium carbonate.....	lb.	.48	—	.55
Manganese dioxide, U. S. P.....	lb.	.10	—	.11
Magnesium carbonate, tech.....	lb.	.14 1/4	—	.14 1/4
Nickel salt, single.....	lb.	.11 1/4	—	.11 1/4
Nickel salt, double.....	lb.	1.70	—	1.70
Phosphorus, red.....	lb.	2.10	—	2.15
Phosphorus, yellow.....	lb.	2.10	—	2.15

Potassium bichromate.....	lb.	45½	46
Potassium bromide granular.....	lb.	1.35	1.40
Potassium carbonate calcined, 85-90 per cent.....	lb.	.75	—
Potassium chlorate, crystals.....	lb.	.43	.45
Potassium cyanide, 98-99 per cent.....	lb.	Nominal	—
Potassium iodide.....	lb.	2.90	3.00
Potassium muriate 80-85 p.c. basis of 80 p.c.....	ton	350.00	375.00
Potassium nitrate.....	lb.	.28	.30
Potassium permanganate.....	lb.	3.85	3.90
Potassium prussiate, red.....	lb.	2.70	2.80
Potassium prussiate, yellow.....	lb.	1.27	1.35
Potassium sulphate, 90-95 p.c. basis 90 p.c.....	ton	400.00	—
Rochelle salts.....	lb.	.39	.39½
Salammoniac, gray gran.....	lb.	10½	11½
Salammoniac, white gran.....	lb.	10	10½
Sal soda.....	100 lb.	1.25	1.50
Salt cake.....	100 lb.	1.25	1.50
Silver cyanide, based on market price of silver.....	oz.	.57	.59
Silver nitrate.....	oz.	3.05	3.10
Soda ash, 58 per cent. light, flat.....	100 lb.	4.00	—
Soda ash, 58 per cent. dense, flat.....	100 lb.	13½	13½
Sodium acetate.....	lb.	2.15	2.25
Sodium benzoate.....	lb.	.02½	.02½
Sodium bicarbonate, domestic.....	lb.	.18½	.18½
Sodium bicarbonate, English.....	lb.	.05½	.06½
Sodium bichromate.....	lb.	.23	.25
Sodium bisulphite, powd.....	lb.	.48	.51
Sodium chloride.....	lb.	.18½	—
Sodium cyanide.....	lb.	.01½	.02
Sodium fluoride, commercial.....	lb.	4.65	4.75
Sodium hyposulphite.....	lb.	.32	.35
Sodium nitrate, 95%.....	100 lb.	.55	.60
Sodium nitrite.....	lb.	.04	.04½
Sodium peroxide.....	lb.	.35	.36
Sodium phosphate.....	100 lb.	1.80	2.00
Sodium prussiate, yellow.....	lb.	.02½	.03½
Sodium silicate, liquid.....	100 lb.	.03½	.04½
Sodium sulphide, 30 per cent crystals.....	lb.	.04	.05½
Sodium sulphide, 60 per cent, fused.....	lb.	.35	.40
Sodium sulphite.....	lb.	.06	.06½
Strontium nitrate.....	lb.	.15	.40
Sulphur chloride, drums.....	100 lb.	4.05	4.10
Sulphur dioxide, liquid, in cylinders.....	100 lb.	3.70	3.85
Sulphur, flowers, sublimed.....	100 lb.	60.00	65.00
Sulphur, roll.....	ton	.19½	.19½
Sulphur, crude.....	lb.	.64½	.65
Tin bichloride, 50 deg.....	lb.	.35	.38
Tin oxide.....	lb.	.10½	.10½
Zinc carbonate.....	lb.	.50	.18
Zinc chloride.....	lb.	.17	.15
Zinc cyanide.....	lb.	.14½	.15
Zinc dust 350 mesh.....	lb.	.05½	.05½
Zinc oxide, American process XX.....	lb.	—	—
Zinc sulphate.....	lb.	—	—

Coal Tar Products (Crude)

Benzol, pure, water white.....	gal.	.45	.46
Benzol, 90 per cent.....	gal.	.50	.52
Toluol, pure water white.....	gal.	2.00	—
Xylol, pure, water white.....	gal.	.45	.50
Solvent naphtha, water white.....	gal.	.17	.22
Solvent naphtha, crude, heavy.....	gal.	.13	.16
Cresote oil, 25 per cent.....	gal.	.33	.35
Dip oil, 20 per cent.....	gal.	.29	.30
Pitch, various grades.....	ton	8.00	20.00
Carbolic acid, crude, 95-97 per cent.....	lb.	1.05	1.10
Carbolic acid, crude, 50 per cent.....	lb.	.60	.65
Carbolic acid, crude, 25 per cent.....	lb.	.32	.35
Cresol, U. S. P.....	lb.	.19	.20

Intermediates, Etc.

Alpha naphthol, crude.....	lb.	1.10	—
Alpha naphthol, distilled.....	lb.	1.60	—
Alpha naphthylamin.....	lb.	.60	.65
Aniline oil, drums extra.....	lb.	25½	.26
Aniline salts.....	lb.	31½	.33
Anthracene, 50 per cent.....	lb.	.10	—
Benzaldehyde.....	lb.	4.00	4.50
Benzidine, base.....	lb.	1.80	1.85
Benzidine, sulphate.....	lb.	1.40	1.50
Benzoic acid.....	lb.	2.50	—
Benzyl chloride.....	lb.	1.75	2.00
Beta naphthol benzoate.....	lb.	7.00	8.00
Beta naphthol, sublimed.....	lb.	.87½	.90
Beta naphthylamin com.....	lb.	2.50	—
Dichlor benzol.....	lb.	.12	.18
Diethylaniline.....	lb.	3.75	4.25
Dinitro benzol.....	lb.	.34	.50
Dinitrochlorbenzol.....	lb.	.42	.44
Dinitronaphthalene.....	lb.	.55	.60
Dinitrotoluol.....	lb.	.57	.62
Dinitrophenol.....	lb.	.55	.62
Dimethylaniline.....	lb.	.60	.65
Diphenylamine.....	lb.	1.00	—
H-acid.....	lb.	3.00	3.50
Metaphenylenediamine.....	lb.	1.75	1.80
Monochlorbenzol.....	lb.	.22	.23
Naphthalene, flake.....	lb.	.09½	.10
Naphthalene, balls.....	lb.	.10	.11
Naphthionic acid, crude.....	lb.	1.50	1.75
Naphthylamin-di-sulfonic acid.....	lb.	1.00	1.10
Nitro naphthalene.....	lb.	.45	.50
Nitro toluol.....	lb.	.50	.55
Ortho-amidophenol.....	lb.	.90	1.00
Ortho-toluidine.....	lb.	.75	1.00
Para-amidophenol, base.....	lb.	4.50	5.00
Para-amido-phenol, H. Ch.....	lb.	5.25	5.75
Paranitraniline.....	lb.	1.10	—
Para-nitro-toluol.....	lb.	1.50	1.60
Paraphenylenediamine.....	lb.	3.50	4.00
Para-toluidine.....	lb.	2.25	—
Phenol, U. S. P.....	lb.	.52	.53
Resorcin, technical.....	lb.	8.00	9.00
Resorcin, pure.....	lb.	13.00	13.50
Salicylic acid.....	lb.	1.35	1.38
Salol.....	lb.	1.85	2.00
Sulphanilic acid.....	lb.	.32	.35
Tolidin.....	lb.	2.50	—
Tolidine-mixture.....	lb.	.75	.85

Petroleum Oils

Crude (at the Wells)			
Pennsylvania.....	bbl.	3.50	—
Corning, Ohio.....	bbl.	2.60	—
Somerset, Ky.....	bbl.	2.40	—
Wooster, Ohio.....	bbl.	2.38	—
Indiana.....	bbl.	1.98	—
Illinois.....	bbl.	2.12	—
Oklahoma and Kansas.....	bbl.	2.00	—
Caddo, La., light.....	bbl.	2.00	—
Corsicana, Tex., light.....	bbl.	2.00	—
California.....	bbl.	.98	1.32
Gulf Coast.....	bbl.	1.00	—

Fuel Oil

New York.....	gal.	.10½	—
Pittsburgh.....	gal.	.07½	.10
Oklahoma-Kans.....	bbl.	.70	1.55
Texas.....	bbl.	1.60	—
Los Angeles.....	bbl.	1.45	—
San Francisco.....	bbl.	1.45	—

Gasoline (Wholesale)

New York.....	gal.	.24	—
Boston.....	gal.	.25	—
Pittsburgh.....	gal.	.24	—
Chicago.....	gal.	.21	—
Oklahoma.....	gal.	.23	—
San Francisco.....	gal.	.20	—

Lubricants

Black, reduced, 20 gravity, 25-30 cold test.....	gal.	.13½	.14
Cylinder, light.....	gal.	.21	.26
Cylinder, dark.....	gal.	.18	.19
Paraffine, high viscosity.....	gal.	.29½	.30
Paraffine, 903 sp. gr.....	gal.	.21½	.22
Paraffine, 865 sp. gr.....	gal.	.18½	.19

Flotation Oils

(Prices at New York unless otherwise stated)

Pine oil, crude, f.o.b. Florida.....	gal.	.44	—
Pine oil, steam distilled, sp. gr. 0.925-0.940.....	gal.	.50	—
Pine oil, destructively distilled.....	gal.	.43	.53
Pine-tar oil, sp. gr. 1.025-1.035.....	gal.	.30	—
Pine-tar oil, double refined, sp. gr. 0.965-0.990.....	gal.	.37	—
Pine oil, light, sp. gr. 0.950, tank cars, f.o.b. works.....	gal.	.26	—
Pine oil, heavy, sp. gr. 1.025, tank cars, f.o.b. works.....	gal.	.32	—
Pine tar, thin, sp. gr. 1.060-1.080.....	gal.	.40	—
Turpentine, crude, sp. gr. 0.980-1.000.....	gal.	.21	—
Hardwood oil, f.o.b. Michigan, sp. gr. 0.960-0.990.....	gal.	.19½	—
Hardwood oil, f.o.b. Michigan, sp. gr. 1.06-1.08.....	gal.	.30½	—
Wood creosote, ref. f.o.b. Florida.....	gal.	.30½	—

Vegetable and Other Oils

China wood oil.....	lb.	.22	.23
Cottonseed oil, crude.....	gal.	1.30	—
Linseed oil, raw, cars.....	gal.	1.13	1.16
Peanut oil, crude.....	gal.	1.38	—
Rosin oil, first run.....	gal.	.35	—
Rosin oil, fourth run.....	gal.	.66	—
Soya bean oil, Manchuria.....	lb.	.16½	.17
Turpentine, spirits.....	gal.	.54	—

Miscellaneous Materials

Barytes, floated, white, foreign.....	ton	40.00	50.00
Barytes, floated, white, domestic.....	ton	30.00	36.00
Beeswax, white, pure.....	lb.	.56	.64
Carnauba wax, for.....	lb.	.62	—
Casoin.....	lb.	.22	.30
Chalk, light, precipitated, English.....	lb.	—	—
Feldspar.....	ton	8.00	12.00
Fuller's earth, powdered.....	100 lb.	1.00	1.50
Osokerite, crude, brown.....	lb.	.65	.75
Osokerite, American, refined, white.....	lb.	.75	1.00
Red lead, dry, carloads.....	lb.	.10	.11½
Rosin, 280 lb.....	bbl.	6.85	—
Soapstone.....	ton	10.00	12.50
Talc, American, white.....	ton	15.00	18.00
White lead, dry.....	lb.	.09	.10

Refractories, Etc.

(F.O.B. Works)

	net ton	Nominal	
Chrome brick.....	net ton	Nominal	
Chrome cement, Grecian.....	per 1000	50.00	55.00
Clay brick, light quality fireclay.....	per 1000	35.00	40.00
Clay brick, second quality.....	per 1000	30.00	35.00
Magnesite, raw.....	ton	40.00	55.00
Magnesite, calcined.....	ton	85.00	90.00
Magnesite, Grecian, dead burned.....	net ton	135.00	140.00
Magnesia brick, Grecian, 9x4½x2½.....	per 1000	50.00	60.00
Silica brick.....	per 1000	50.00	60.00

Ferrolloys

Ferrocobaltitium, 15-18 per cent, carloads, f.o.b. Niagara Falls, N. Y.....	ton	160.00	—
Ferrocobaltitium, per lb. of Cr.....	lb.	.35	.40
Ferromanganese, domestic, delivered.....	ton	275.00	—
Ferromanganese, English.....	ton	325.00	—
Ferromolybdenum, per lb. of Mo.....	lb.	4.00	4.40
Ferrosilicon, 75 per cent, f.o.b. N. Y.....	ton	230.00	260.00
Ferrosilicon, 50 per cent, carloads, del., Pittsburgh.....	ton	200.00	250.00
Ferrosilicon, 50 per cent, contract.....	ton	100.00	150.00
Ferrotungsten, 75-85 per cent, f.o.b. Pittsburgh.....	lb.	2.40	2.60
Ferrouanium, f.o.b. works, per lb. of U.....	lb.	7.00	7.50
Ferrovanadium, f.o.b. works.....	lb.	3.25	3.50

Ores and Semi-finished Products

Antimony ore, per unit.....	1.60	1.75
Chrome ore, 48 per cent minimum, f.o.b. Cal., per unit.....	ton	.90
Manganese ore, 48 per cent and over, per unit.....	ton	1.20
Manganese ore, chemical.....	ton	\$100.00
Molybdenite, per lb. of MoS ₂	lb.	2.20
Tungsten, Scheelite, per unit of WO ₃	ton	26.00
Tungsten, Wolframite, per unit of WO ₃	ton	25.00
Uranium oxide, 96%.....	lb.	3.25
Vanadium Pentoxide, 99%.....	lb.	10.50
Pyrites, foreign.....	unit	.16
Pyrites, domestic.....	unit	.11

INDUSTRIAL

Financial, Construction and Manufacturers' News

New Companies

The AERO PHOTOGRAPHY COMPANY, New York. Capital, \$25,000. To manufacture cameras and photographic supplies for use on airplanes. Incorporators are: R. J. Pomeroy, R. R. Appleby and W. P. Hammond, 52 Broadway.

The ALLENTOWN MOTOR COMPANY, Wilmington, Del. Capital, \$100,000. To manufacture automobiles and motors. Incorporators: Franklin L. M. E. and L. F. Mettler, Wilmington.

The ALUMINUM SOLDER MANUFACTURING COMPANY, New Castle, Pa. Capital, \$25,000. To manufacture aluminum solder. Incorporators: Frank E. Alborn, Andrew Knittel and J. V. Cunningham, New Castle.

The AMALGAMATED ANILINE DYE COMPANY, New York. Nominal capital, \$5,000. To manufacture chemicals, dyes and kindred products. Incorporators are: Lawrence A. Sherwood, Alfred Jaretski, Jr., and Stoddard M. Stevens, Jr., 627 West One Hundred and Fifteenth Street, New York.

The AMERICAN AIRCRAFT COMPANY, Dover, Del. Capital, \$500,000. To manufacture aeroplanes and other aircraft. Incorporators: M. M. Clancy, C. M. Egner and C. L. Rimlinger, Wilmington.

The AMERICAN AIR CRAFT ARMS COMPANY, Dover, Del. Capital, \$500,000. To manufacture firearms for use on aircraft.

The AMERICAN-CANADIAN RESOURCES COMPANY, Dover, Del. Capital, \$2,000,000. To manufacture engines and machinery of various kinds. Incorporators are: George G. Stiegler, William F. O'Keefe and M. Gehrmann, Wilmington.

The AMERICAN PUTTY & PAINT COMPANY, Jersey City, N. J. Capital, \$125,000. To manufacture putty, paints and kindred products. Incorporators: H. and R. R. Max and Morris Alexander, Jersey City.

The AMERICAN ROLLING MILL COMPANY, Cincinnati, Ohio. Incorporated under Illinois laws. Capital, \$21,000,000. To operate steel and rolling mills.

The APEX PULVERIZING MILLS COMPANY, Brooklyn, N. Y. Capital, \$10,000. Incorporators are: A. T. and C. A. Beach and H. F. Kleinfeldt, 220 Broadway.

The ARCO CHEMICAL COMPANY, New York. Nominal capital, \$5,000. To manufacture chemicals and allied products. Incorporators are: J. N. and E. Goetshoff and A. Radtzyk, 982 Prospect Avenue, Brooklyn.

The ATLAS WELDING COMPANY, Elizabeth, N. J. Capital, \$50,000. To manufacture a patented cutting and welding torch. Incorporators are: John Grouss, Clarence E. Pryor, Walter W. von Todenwirth, Elizabeth, and Charles Ackerman, Brooklyn, N. Y.

The BITUMINO ENAMEL COMPANY, Gloucester City, N. J. Capital, \$100,000. To manufacture bituminous enamel. Incorporators: Elmer J. Shinn, Hugh V. Ramsay and Frank Breckenridge, Gloucester City.

The BLACK ROCK IRON MINING COMPANY, Johnston, Pa. Capital, \$20,000. To engage in a general iron mining business. Incorporators are: Frederick K. Sheesley, Johnston; William A. Perry, Pittsburgh; Edward G. Lewis, E. E. Cramer and Charles Munson, Dover, Del.

The BUSHWICK CORK COMPANY, Brooklyn, N. Y. Nominal capital, \$5,000. To manufacture cork. Incorporators: N. Verder and W. F. Betts, 1105 Nostrand Avenue.

The COLOR SERVICE CORPORATION, Inc., New York. Capital, \$50,000. To manufacture chemicals, dyes and kindred products. Incorporators: G. Gibbon, H. L. Schaefer and J. T. Fenlon, 55 Liberty Street.

The CONNECTICUT BRASS & MANUFACTURING COMPANY, Wilmington, Del. Capital, \$4,000,000. To manufacture brass goods of various kinds. Incorporators: M. M. Clancy, Wilmington, and C. M. Egner, Elkton, Md.

The CONTINENTAL CONSTRUCTION CORPORATION, Dover, Del. Capital, \$100,000. To manufacture railway supplies of various kinds.

The DeVogel Machine & Welding Company, Paterson, N. J. Capital, \$25,000. To

manufacture tools and machinery. Incorporators are: John, Richard and L. DeVogel, Paterson.

The EUGENE DIETZGEN COMPANY, Dover, Del. Capital, \$3,500,000. To manufacture supplies for draftsmen, artists, etc.

The ECONOMY ELECTRIC COMPANY, Norfolk, Va. Capital, \$50,000. To manufacture electrical supplies. Incorporators: E. R. and Charles A. Page, Norfolk.

The EDEL LABORATORIES, Inc., Newark, N. J. Capital, \$50,000. To operate chemical laboratories. Incorporators are: Milton E. Crawley, Edward H. Schwartz and Homer D. Smith, Newark.

The JOSEPH ELIAS COMPANY, Inc., Borough of Queens, N. Y. Capital, \$300,000. To manufacture glass specialties. Incorporators are: John G. Griffin, Norman S. Goetz and T. Joffe, New York.

The EMPIRE ELECTRIC STEEL CORPORATION, New York. Capital, \$500,000. Incorporators are: Eric Pusinelli, George R. Hamilton and E. H. Rapp, New York.

The FAILING-EASTBROOKS COMPANY, Inc., Albany, N. Y. Capital, \$5,000. To manufacture chemicals, etc. Incorporators are: Frank D. Eastbrooks, John P. Failing and E. H. Vandura, Albany.

The FARBEN-FABRIKEN OF ELBERFELD COMPANY, New York. Capital, \$100,000. To manufacture dyestuffs and kindred products. Incorporators are: G. A. Reiss, W. F. and T. M. McDermott, 15 Dey Street, New York.

The FARMERS MACHINE & CHEMICAL COMPANY, Rochester, N. Y. Capital, \$100,000. To manufacture machinery and chemicals. Incorporators: J. N. Marshall, W. S. McKinney and S. G. H. Covell, Rochester.

The FEINDEL & PASQUIER CHEMICAL CORPORATION, New York. Capital, \$10,000. To manufacture chemicals, etc. Incorporators are: E. E. Feindel and M. Pasquier, 431 West Twenty-fourth Street, New York.

The FIDELITY TIRE & RUBBER COMPANY, Jersey City, N. J. Capital, \$5,000. To manufacture rubber tires and kindred specialties. Incorporators: Richard Kramer, Clason Point, L. I.; James L. Meltzer and F. O. Sheehan, New York.

M. GOTTESMAN & COMPANY, Inc., New York. Capital, \$650,000. To operate pulp, paper and jute mills. Incorporators: S. Schwartzman, M. Brenner and E. M. Souza, 111 Broadway.

The GRANT HAMMOND ARMS CORPORATION, New York. Capital, \$1,000,000. To manufacture firearms. Incorporators: S. B. Howard, George V. Reilly, and Arthur W. Britton, 65 Cedar Street, New York.

The HEDD CHEMICAL COMPANY, Hoboken, N. J. Capital, \$15,000. To manufacture chemicals and kindred products. Incorporators: William S. Driesen, Milton Hart, and Harry Ruff, Chicago, Ill.

The HERCULES STORAGE BATTERY COMPANY, West New York, N. J. Capital, \$20,000. To manufacture storage batteries. Incorporators are: A. J. Wiencke, A. J. Ellis, and M. Wiencke, all of North Bergen.

The HIGLO SPECIALTY COMPANY, Dover, Del. Capital, \$100,000. To manufacture specialties made of iron, brass, etc.

CHARLES H. HUISKING, Inc., New York. Capital, \$300,000. To manufacture chemicals and kindred products. Incorporators are: G. P. C. F. and C. L. Huisling, 145 Lincoln Road, Brooklyn, N. Y.

The IMPERIAL TIRE & RUBBER COMPANY, Philadelphia, Pa. Capital, \$200,000. To manufacture rubber goods. Incorporators are: I. S. Shubert, H. Nelson and V. T. Carson, all of Philadelphia.

The IMPROVED RUBBER COMPANY, Inc., Bayonne, N. J. Capital, \$100,000. To manufacture rubber products of various kinds. Incorporators: A. A. de Bonneville, Bayonne; E. M. Snell, New York, and Alfred S. Perry, Fairfield, Conn.

The INDEPENDENT MANUFACTURING COMPANY, Carlsbad, N. J. Capital, \$20,000. To manufacture paper, chemicals, oils, etc. Incorporators are: John T. Mulhall, H. Beam, and J. M. Beam, Jersey City.

The INTERNATIONAL DYMALKON PROCESS CORPORATION, New York. Capital, \$500,000. To manufacture silicon and aluminum, and engage in a general foundry and

machine business. Incorporators: J. A. Poulin, E. O. Anderson, and P. A. Stilwell, 38 Fort Washington Avenue, New York.

The J. B. D. RUBBER COMPANY, Arlington, N. J. Capital, \$50,000. To manufacture rubber goods, chemicals, etc. Incorporators: B. A. Dave, Alfred G. Berg, and James H. Robertson, all of Arlington.

The E. J. KERNS MANUFACTURING COMPANY, Newark, N. J. Capital, \$50,000. To manufacture aeroplanes. Incorporators are: Edward J. and Francis J. Kerns, and James F. Kelly, Newark.

The KINGS COUNTY IRON & FOUNDRY COMPANY, Brooklyn, N. Y. Capital, \$200,000. Incorporators are: C. S. Woodman, T. E. Hodgskin, and J. Friedman, 20 Nassau Street, New York.

KUTTROFF, PICKHARDT & COMPANY, New York. Capital, \$200,000. To manufacture chemicals, dyes, and kindred products. Incorporators are: C. Pickhardt and A. and F. Kuttroff, 128 Duane Street.

The LEIGHTON-MCMULLIN COMPANY, Inc., Philadelphia, Pa. Capital, \$50,000. To manufacture paints, etc. William C. McMullin, treasurer.

The LIBERTY CARBON COMPANY, Maytown, Ky. Capital, \$100,000. To manufacture carbon black. Incorporators are: W. R. Fowkes, J. A. Wetherell, and S. J. McConnell, all of Clarksburg, W. Va.

The MINERVA LABORATORIES, Inc., Chicago, Ill. Capital, \$30,000. To manufacture chemicals and allied products. Incorporators: William H. Schleser, Carl W. Winkler, and G. Van Schanck, all of Chicago.

The MOUNTAIN PAPER COMPANY, New York. Nominal capital, \$5,000. To manufacture paper. Incorporators are: C. S. Hunter, L. Lowenstein, and P. Bernstein, 220 Audubon Avenue, New York.

The MOUNT JOY MAGNESIA COMPANY, Mount Joy, Pa. Capital, \$150,000. Principal incorporator: O. G. Longnecker.

The NEMA CHEMICAL LABORATORY, New York. Capital, \$100,000. To manufacture chemicals and kindred products. Incorporators: L. Scelfo, C. S. Streva, and E. Sivelli, 165 Broadway, New York.

The NIASCO CHEMICAL COMPANY, Hoboken, N. J. Capital, \$250,000. To manufacture chemicals. Incorporators: H. J. Camby, R. E. Hetzel, and P. Frankenhoff, Hoboken.

The OXFORD FOUNDRY & MACHINE COMPANY, Oxford, N. J. Capital, \$50,000. To manufacture iron and steel products. Incorporators are: William A. Bartley, Oxford; Howard L. Coas, West Orange, and Bernard Brady, Lake Hopatcong, N. J.

The OXY CHEMICAL COMPANY, Niagara Falls, N. Y. Capital, \$10,000. To manufacture chemicals and kindred products. Incorporators: Leon W. Gibson, Rollin A. Chardavoyne, and A. B. Smith, Niagara Falls.

The PAQUET WINDOW GLASS MACHINE COMPANY, Jeannette, Pa. Capital, \$10,000. To manufacture machinery for producing window glass. Robert Hordis, treasurer.

The PATENT VULCANITE ROOFING COMPANY, Dover, Del. Capital, \$5,000,000. To manufacture patent roofing material.

The PERRAULT PAPER PRODUCTS COMPANY, Dover, Del. Capital, \$40,000. To manufacture paper products. Incorporators: Jesse H. Perrault, Albert H. Schnoor, and William H. Marcus.

The PHENOL CHEMICAL COMPANY, Chicago, Ill. Capital, \$2,500. To manufacture chemicals. Incorporators are: L. C. Barron, William A. Bither, and E. W. Weiss, all of Chicago.

The PIGMENT PRODUCT CORPORATION, New York. Capital, \$25,000. To manufacture chemicals, colors, etc. Incorporators: A. Blackburne, J. M. Herzberg, and W. L. Tucker, 141 Broadway, New York.

The POCAHONTAS GRAPHITE COMPANY, Cullman, Ala. Capital, \$200,000. To manufacture graphite, iron and steel products. Incorporators: W. L. Shumate, Jr., H. E. McCormack, A. P. Smith, and George H. Parker, Cullman.

The RED DEVIL MANUFACTURING COMPANY, St. Louis, Mo. Capital, \$100,000. To manufacture Red Devil Carbon Remover. Incorporators: B. E. Bollinger, Clay E. Herbst and L. O. Honig, St. Louis.

The RIVERSIDE IRON & METAL COMPANY, Paterson, N. J. Capital, \$10,000. To manufacture iron and steel. Incorporators: S. and A. Seager, and A. Beaver, Paterson.

The RUBBER INSULATED METALS CORPORATION, Wilmington, Del. Capital, \$500,000. To manufacture electrical, chemical, and metallurgical preparations and surfaces for insulated wires, etc.

The SALEM FELTEX COMPANY, Salem, N. J. Capital, \$750,000. To manufacture lino-

leum. Incorporators: Neil L. Campbell, Walter S. Shields, and Kenneth Campbell, Salem.

THE SCHOELLNER & HORBACH MANUFACTURING COMPANY, Newark, N. J. Capital, \$125,000. To manufacture chemicals and allied products. Incorporators: John Schoellner, K. A. Horbach, and J. Crowley, Newark.

F. SCHOETTLE, INC., Philadelphia, Pa. Capital, \$200,000. To manufacture paper boxes. W. C. Schoettle, treasurer.

THE SOUTH JERSEY FOUNDRY COMPANY, Camden, N. J. Capital, \$250,000. To manufacture cast iron and pipe. Incorporators are: Herbert J. Koehler, K. L. Praisen, and J. F. Sutton, Camden.

THE U. & J. CARBURETOR COMPANY, Chicago, Ill. Capital, \$250,000. To manufacture carburetors, etc. Incorporators: J. W. Johnson, Frank A. Urwan, and George E. Brannan, Chicago.

THE UNION CARBIDE & CARBON CORPORATION, Niagara Falls, N. Y. Active capital, \$15,000,000. Incorporators: M. T. Herrick, C. G. K. Billings, and C. A. Coffin, 120 Broadway, New York.

THE VICTORIA IRON WORKS, Northampton, Mass. Capital, \$10,000. To manufacture machinery. Incorporators: D. Edward Hennessy, Holyoke; Richard H. Dickson, Holyoke, and F. Hennessy, Holyoke.

THE WESTERN POTASH & CHEMICAL COMPANY, LTD., Los Angeles, Cal. Capital, \$100,000. To manufacture potash, chemicals, and kindred products. Incorporators: A. Kauek, John L. Prince, E. Oppenhausser, M. B. Bender, L. Miller, John T. Cave, Joseph Rosenblum and Stewart Silliman, all of Los Angeles.

Construction and Operation

Alabama

BESSEMER.—Rapid progress is being made in the rebuilding of the Little Bell furnace of the Tennessee Coal, Iron & Railroad Company at Robertstown, and the company is planning to inaugurate operations before the close of the month. The furnace, which is the oldest of the company in Bessemer, and which has not been in operation for a considerable time, will be devoted to the production of ferromanganese exclusively.

Arizona

KINGMAN.—The Union Basin Mining Company is planning for the immediate rebuilding of its mill and plant at Golconda, recently destroyed by fire at a loss of \$250,000.

California

MARTINEZ.—The Butters electrolytic zinc plant at Martinez is starting operations. R. W. French of this city is in charge of the installation of machinery and apparatus. Great Western Power service is being extended into the properties, where enormous quantities of electric power will be consumed in reducing ore.

SAN FRANCISCO.—The Beckman & Linden Engineering Corporation have started the construction of a chemical plant on San Francisco Bay for the manufacture of strontium hydrate, strontium carbonate, strontium nitrate, blanc fixe (precipitated barium sulphate), barium chloride, barium carbonate, barium nitrate and barium peroxide. Mr. Linden states that the new plant will be able to supply the trade in January.

BAKERSFIELD.—Fire recently completely destroyed the refinery of the Union Oil Company in the Kern River fields, near Bakersfield, with total loss estimated at \$225,000. The plant will be immediately rebuilt.

FRESNO.—The Pacific Gas & Electric Company is making rapid progress in the construction of its new generating plant on the West Side branch of the Southern Pacific Railroad. The machine shop has been entirely completed, and the main building of the plant is now in course of construction. The works are estimated to cost about \$500,000.

FILLMORE.—The Ventura Refining Company has broken ground for the construction of a large refining works to specialize in the production of wax from crude oil. The plant is estimated to cost \$300,000. F. E. Snowden is manager.

LOS ANGELES.—Work on the new factory building of the Gillilan Brothers Smelting & Refining Company at Eleventh and Wall Streets, has been completed, and the company has inaugurated operations for the manufacture of platinum pointed

magneto parts, grinders, motor and generator brushes, etc.

SAN DIEGO.—The United States Shipbuilding Company, recently organized, will operate a works for the manufacture of airplanes in connection with its new shipbuilding plant to be erected on the tidelands. A site for the plant has been acquired.

SAN FRANCISCO.—The California Fertilizer Works, Evans Avenue, between Lane and Mendell Streets, are having plans prepared for the rebuilding of their plant which was entirely destroyed by fire recently at a loss of \$250,000.

STOCKTON.—The National Paper Products Company has had plans prepared for the construction of a large new paper mill in the western part of the city. The plant will cost approximately \$1,000,000. M. R. Higgins is president; A. E. Mandel is manager.

WHITTIER.—A large new one- and two-story chemistry building, about 75 x 156 ft., will be erected at Whittier College, contract for which has been awarded to George A. Daniels, Pasadena, at a price of \$25,211.

Connecticut

BRIDGEPORT.—The Raybestos Company, specializing in the manufacture of automobile brake lining, has filed plans for the construction of a new plant on East Main Street, Stratford, Conn. The structure will be one story, about 90 x 180 ft., and will cost \$50,000. Contract for erection has been awarded.

PLAINVILLE.—The Trumbull Electric Company, manufacturer of electrical supplies, is making rapid progress in the construction of a new three-story and basement addition to its plant, about 50 x 100 ft. When completed, the structure will cost about \$50,000.

Delaware

NEW CASTLE.—The Wilmington Fibre Specialties Company has awarded a contract for extensive improvements and alterations in its boiler house and pumping station. Harry Lynch, 715 Tatnall Street, Wilmington, is the contractor.

SOUTH WILMINGTON.—Fire on Oct. 23 destroyed two large buildings at the plant of the Pyrites Company, Ltd., manufacturer of chemicals, etc. This plant has only been in operation for a few months. The loss is estimated at about \$100,000. The destroyed structures will be immediately rebuilt.

WILMINGTON.—A portion of the plant of Cahill & Company, Second and French Streets, was destroyed by fire on Nov. 2, with loss estimated at \$250,000. The company specializes in the manufacture of automobiles and carriages.

Florida

TAMPA.—The Florida Brewing Company is having plans prepared for the remodeling of its entire plant for the establishment of a sugar refinery, the company proposing to discontinue its regular manufacture. New machinery will be installed for handling about 100 tons of sugar daily. S. V. M. Ybor is manager.

Illinois

CHICAGO.—James H. Rhodes & Company, Twenty-eighth Street and Albany Avenue, are making rapid progress in the construction of a new addition to their plant on the line of the Illinois Northern Railroad. The structure, which will cost about \$40,000, is to provide for increased capacity. The company manufactures industrial chemicals.

CHICAGO.—The Inter-Ocean Refining Company, 440 South Michigan Avenue, has had plans prepared for the construction of a new plant on Joliet Road and West Fifty-fourth Street, Lyons, Ill., to consist of kiln house, wax plant, boiler room, office building, filter house, pumping station, stills and auxiliary structures.

DECATUR.—The Comet Automobile Company, Orlando Building, has awarded a contract for the erection of its proposed new two-story automobile plant, about 50 x 80 ft., and one-story building, about 150 x 600 ft., to cost approximately \$135,000. The M. J. Hoffman Construction Company, Rookery Garage Building, Evansville, Ind., is the contractor.

CHICAGO.—The Edward Valve & Manufacturing Company, 72 West Adams Street, will build a new one and two-story foundry at its works at East Chicago, Ind., to cost about \$15,000. The structure will be about 90 x 150 ft.

Kansas

INDEPENDENCE.—The Carter Oil Company is said to be planning for the construction of a large refinery and is considering sites for the plant in Augusta or El Dorado. The company has leased large areas of land in Cowley, Greenwood and Butler Counties during the past few months, and is planning for extensive development of the properties. The capital has been increased from \$50,000 to \$4,360,810. Headquarters of the company are at Tulsa, Okla.

Kentucky

NICHOLASVILLE.—The plant and business of the Central Pigment Company has been acquired by new interests, who are planning to specialize for the present in the production of barytes and fluorspar and at a later date to handle other products.

Louisiana

KENNER.—The Dixie Steel Corporation has acquired a site of 25 acres of land in Kenner, near New Orleans, and is planning for the erection of a new steel plant. Construction of the new works will be started immediately, and it is planned to give employment to about 300 hands for initial operations. This will be the first rolling mill in this section of the country.

NEW ORLEANS.—The Union Seed & Fertilizer Company is planning to increase the capacity of its plant to 40 tons of sulphuric acid daily by the construction of new additions to its sulphuric acid works at a cost of approximately \$125,000.

NEW ORLEANS.—A new sulphuric acid plant with daily capacity of 60 tons, is being planned by Swift & Company, Chicago, Ill., at its local plant. The new works are estimated to cost about \$250,000. The company is also planning for the construction of a large addition to its local fertilizer manufacturing plant.

Maryland

BALTIMORE.—The Porcelain Enamel & Manufacturing Company, O'Donnell Street, has had plans prepared for the construction of a new one-story addition, about 120 x 220 ft., to its plant on Bayard Street. The structure is estimated to cost about \$100,000.

BALTIMORE.—Plans for the erection of a new three-story machine shop, about 115 x 180 ft., on Ramsay Street, have been filed by Bartlett, Hayward & Company, Scott and Hamburg Streets. Contract for construction has been awarded to Morrow Brothers, Fidelity Building, Baltimore.

BALTIMORE.—The Baltimore Dry Docks & Shipbuilding Company has had plans prepared for the erection of six one-story, brick and concrete shop buildings at its plant.

Massachusetts

HOLYOKE.—The Deane Steam Pump Works, 37 Appleton Street, is building a new one-story brick and steel addition to its plant, about 150 x 165 ft., to cost \$50,000. The Casper Ranger Construction Company, Bond and Appleton Streets, Holyoke, has the contract for erection.

SOMERVILLE.—The American Tube Works has awarded a contract for the construction of a one-story addition to its plant.

SOUTH BOSTON.—F. E. Atteaux & Company, manufacturers of chemicals, have awarded a contract for the construction of a new reinforced-concrete plant, two story, about 65 x 170 ft. The Turner Construction Company, 242 Madison Avenue, New York, is the contractor.

Michigan

DETROIT.—The Ford Motor Company has commenced the construction of its new plant on the 134 acre site recently acquired on the outskirts of the city. The new works will include blast furnaces for the production of steel for their own use, a plant for the manufacture of rubber tires, and a factory for the production of motor car bodies. It is estimated that when completed, the new buildings, including the sites, will represent an expenditure of approximately \$20,000,000.

ECORSE.—The Barnes Foundry & Manufacturing Company, Detroit, has taken bids for the erection of a new one-story local foundry, about 164 x 320 ft.

LANSING.—The Duplex Truck Company, manufacturer of motor trucks, is rushing to completion the two new additions to its plant to increase the present capacity. The structures will be two story.

72 x 400 ft., and 72 x 305 ft., and are expected to be ready for occupancy before the close of the month, providing about 100,000 sq. ft. of additional manufacturing space. G. W. Hewitt is secretary and treasurer.

MUSKEGON.—The Advance Brass Manufacturing Company, recently incorporated with a capital of \$25,000, has acquired the building formerly occupied by the Racine Boat Manufacturing Company, and is planning to inaugurate operations at an early date. Alex. G. Wilson, Chicago, Ill., is the general manager of the new company.

Minnesota

HIBBING.—The Town Council has awarded a contract for the erection of a new coal-gas plant for municipal service to The American Gas Construction Company, Newton, Iowa, at a price of \$192,800.

Missouri

MIAMI.—The Big Lead & Zinc Company is planning for the immediate construction of a new concentrating plant on property recently acquired about four miles north of this city. The company has been carrying on experimental drilling for some time, and the ore deposits are said to have thoroughly proved up.

NORTH ST. LOUIS.—The St. Louis Malleable Casting Company has acquired three and one-half acres of property adjoining its two-acre site on North Conduit Avenue, and is planning the erection of additions to more than double its present capacity. The new buildings will include an addition to its malleable plant, which incorporates the gray iron department, the erection of a new steel foundry with a daily capacity of 50 tons, and the construction of a small forging and brass shop. The new works will give employment to 700 additional hands.

Montana

BAKER.—Work has been commenced on the initial unit of the new plant to be erected by the Gas Products Company just east of the city, which will be devoted to the manufacture of carbon black. The new works will include the erection of nine additional buildings, the entire plant to represent an investment of about \$1,000,000. It is expected that the initial unit will be completed before the first of the year. Fred Engstrom, of Smithburg, W. Va., is superintendent.

WHITEHALL.—The Amalgamated Sugar Company is planning for the erection of a large local sugar refinery to cost about \$1,200,000. It is expected that foundations will be ready before the cold weather sets in.

Nebraska

ANTIOCH.—The Western Potash Company has commenced the construction of a large new plant at Antioch, near Alliance, for the manufacture of potash.

New Jersey

CAMDEN.—Fire recently destroyed a portion of the plant of the Waverly Chemical Company, Sixth and Everett Streets, manufacturer of chemicals, with loss estimated at \$20,000, principally in machinery. The fire started in the department used for the manufacture of phenolphthalein.

JERSEY CITY.—The National Air Cell Covering Company, foot of Henderson Street, had plans made for the erection of a new one-story and basement reinforced-concrete addition to its plant, about 60 x 305 feet. John T. Rowland, Jr., 100 Slip Avenue, Jersey City, is the architect.

NEWARK.—The Tuskaloid Company, 310 East Twenty-second Street, New York, had plans prepared for the construction of a new local factory, one-story, about 100 x 200 feet, at Sussex Avenue and Dey Street, to cost about \$10,000. Walter Pryor, 119 Sussex Street, Newark, is engineer. The company specializes in the manufacture of celluloid novelties.

NEWARK.—The Columbus Crystal Company, Avenue R, has taken out a building permit for the construction of a new one-story addition to its plant, about 50 x 185 feet, to cost about \$20,000, to provide for increased capacity.

NEWARK.—Work has been commenced on the proposed new plant of the United Color & Pigment Company to be located in Evergreen Avenue. The works will include the construction of a three-story brick manufacturing building, about 70 x 200 feet, and a one-story power house, about

45 x 90 feet. The structures will cost about \$65,000.

NEWARK.—The John H. Meyer Tire Duck Company, 708 Frelinghuysen Avenue, has taken out a building permit for the erection of a new two-story brick addition to its plant, to cost about \$12,700.

NEWARK.—The Wallington Leather Manufacturing Company, 42 Kent Street, is having plans prepared for the construction of a new plant on Frelinghuysen Avenue to consist of an initial two-story building, about 50 x 150 feet, with smaller building to be used as a power plant, about 48 x 115 feet. Estimated cost of the structures is \$40,000. The company is planning to erect a larger building in the near future, with increased capacity for the power plant, the entire works to cost about \$150,000.

RAHWAY.—Merck & Company, Lincoln Avenue, manufacturers of chemicals, have awarded a contract for the construction of a new one-story brick addition to their plant, about 44 x 100 feet, to cost \$12,000. Salmond Brothers, 526 Elm Street, Arlington, are the contractors.

SOUTH GLASSBORO.—The Whitney Glass Company has completed the erection of its new glass plant, and is planning to inaugurate operations at an early date. The new works will give employment to about 600 hands for initial operations.

NEWMARKET.—The Reade Manufacturing Company, Hoboken, recently organized with a capital of \$250,000, has acquired the plant of Gabrielle & Schall, comprising existing works, about 125 x 310 feet, and eleven acres of property, and will establish a refining plant for cobalt and nickel ores. The new owners plan to commence initial operations before the close of the month.

WASHINGTON.—The Washington Porcelain Company, recently incorporated with a capital of \$100,000, to manufacture porcelain goods, is having plans prepared for the construction of its proposed new plant, to specialize in the production of electric porcelain specialties. The works will consist of three large buildings, with main structure one-story and basement, 40 x 100 feet, and connecting machine shop, also one-story and basement, 40 x 127 feet. Herbert W. and George Sinclair, and Frank P. Gardner, all of Trenton, head the company. W. A. Kleeman, Second National Bank Building, Trenton, is architect.

New Mexico

DEMING.—Fire recently destroyed a portion of the plant of the Empire Smelting & Refining Company, with loss estimated at \$20,000.

New York

NEW YORK.—F. Koshel and S. Singer, 1872 Second Avenue, have had plans prepared for the construction of a new brick smelter, about 20 x 97 feet, on Second Avenue near Fifteenth Street. W. J. Conway, 400 Union Street, is architect.

BROOKLYN.—The Apex Chemical Company, 118 Sanford Street, manufacturer of chemicals, has acquired the plant of the Hygienic Chemical Company at Elizabethport, N. J., and will use the works to provide for increased capacity. The property has a frontage of 308 feet on the Elizabeth River, and was held for sale at about \$60,000.

BROOKLYN.—J. C. Wiarda Company, 273 Greenpoint Avenue, manufacturer of chemicals, has awarded a contract for the construction of a new one-story brick addition to its plant at Huron and Oakland Streets, at a cost of \$5,000.

LONG ISLAND CITY.—The Norma Ball Bearing Company, 1790 Broadway, New York, has acquired property on the Boulevard, and is said to be planning for the erection of a new factory.

BINGHAMTON.—The Bayless Pulp & Paper Company, Philips Building, has commenced the erection of a new paper mill at Austin, Pa., to cost about \$100,000.

NIAGARA FALLS.—The Niagara Falls Gas & Electric Light Company is planning for the immediate erection of a new gas plant; and the extension of its mains throughout the city to provide for increased capacity.

NIAGARA FALLS.—The Niagara Alkali Company, Buffalo Avenue and Union Street, has awarded a contract for the erection of a four-story benzol plant, about 60 x 80 feet. The Peckham Construction Company, Mutual Life Building, Buffalo, is the contractor.

BUFFALO.—The American Radiator Company, 1807 Elmwood Avenue, is planning for the construction of a brick and steel factory addition, to cost about \$55,000.

BUFFALO.—The Kelly Island Lime & Transport Company had plans prepared for the erection of a new one-story lime-burning plant, about 36 x 116 feet, to cost \$20,000.

UTICA.—Ground has been broken for the new plant of the McCoy Iron Works, which will be about 100 x 400 feet, at Mortimer and South Streets. The new works will specialize in the production of structural steel. Headquarters of the company are at Perth Amboy, N. J.

Ohio

CLEVELAND.—Fire recently destroyed a portion of the plant of the Cleveland-Akron Bag Company, with loss estimated at \$200,000. It is said the plant will be immediately rebuilt.

CLEVELAND.—The Interstate Foundry Company, East Sixty-first Street and the Erie Railroad, has awarded a contract for the construction of a new one-story foundry addition to its plant, about 42 x 88 feet, at a cost of \$12,000.

WARREN.—Rapid progress is being made in the construction of the new plant of the Liberty Steel Company, and it is planned to commence the installation of new mill equipment before the first of the year. The company is planning to use the new works for the production of tinplate products exclusively, and expects to inaugurate operations early in February.

Oklahoma

MIAMI.—The Rainbow Zinc & Lead Company is rapidly pushing, to completion the construction of its new mill northwest of Quapaw. New equipment will be installed promptly upon completion of the work, and the company is planning to inaugurate operations at an early date.

Oregon

KLAMATH FALLS.—The Grants Pass Iron & Steel Works are planning for the establishment of a large local machine shop and foundry. The new plant will be equipped to handle all kinds of chilled iron, and make semi-solid castings of all descriptions. B. M. Hall and J. W. Fitzpatrick head the company.

Pennsylvania

PHILADELPHIA.—The Brown Instrument Co. has found it necessary to purchase a large piece of ground located on the south side of its factory. The property of this company now extends along Wayne Avenue from Windrim Avenue on the north to Roberts Avenue on the south, and will permit large extensions to its plant as may be required from time to time.

CLY.—The American Phosphorus Company has acquired property adjoining its plant, and is planning for the construction of a new one-story addition, about 50 x 130 feet, to provide for increased capacity.

LEWIS RUN.—The United Natural Gas Company is making rapid progress in the construction of a new gasoline plant, which will have a capacity of 75,000 gallons daily. More than 50,000,000 cubic feet of gas, which will be secured from the fields of Jefferson, Elk, McKean, Clarion and Forest Counties, will be used daily in the production of gasoline. The cost of the new plant is \$150,000.

NORTH LANCASTER.—The Armstrong Cork Company, Pittsburgh, has acquired sixty-five local building lots on the tract of the Lancaster Development Company, and is said to be planning for the erection of a new plant.

PHILADELPHIA.—The Westmoreland Color & Chemical Company, Twenty-second Street and Allegheny Avenue, has awarded a contract for the erection of a new three-story brick addition to its plant, about 20 x 45 feet, to cost \$25,000. Rush M. Whiteside & Sons, 2115 Wallace Street, Philadelphia, are the contractors.

POTTSTOWN.—The Pottstown Paper Box Company has taken bids for the construction of a new one and two-story addition to its plant, about 50 x 108 feet, to cost \$8,000.

POTTSTOWN.—The National Rubber Company has completed the installation of a large amount of new machinery in its plant, and the company has resumed operations, and is planning to increase its output.

Rhode Island

PROVIDENCE.—The Revere Rubber Company has commenced the construction of a new one-story and basement addition to its plant, about 48 x 64 feet. The new structure will cost about \$25,000, and provide for increased capacity.

South Carolina

CHARLESTON.—The United States Government has had plans prepared for the erection of a new incinerator and can sterilizer building at the local navy yards to cost about \$30,000.

Tennessee

CENTREVILLE.—The National Phosphate & Fertilizer Company has acquired a number of phosphate tracts in Totty's Bend along the Duck River, at a price of about \$185,000, and is planning for extensive development work. The company recently acquired property in the same section at a price of \$82,000.

Texas

HOUSTON.—The Humble Oil & Refinery Company has acquired the plant and business of the Dixie Oil Refinery Company, San Antonio, and the company is planning to use the plant for the refining of oil from wells owned by the Humble company in north Texas. The consideration was about \$350,000. R. S. Sterling is president.

Utah

ALUNITE.—Fire recently destroyed the large potash plant of the Mineral Products Corporation, near Marysville, with loss estimated at approximately \$250,000. The works will be immediately rebuilt. Howard S. Chappell is president.

GUNNISON.—The Gunnison Valley Sugar Company has acquired thirty-two acres of land near the city as a site for a new plant. The work on the factory will be started at once.

SALT LAKE CITY.—The Capital Iron & Metal Company, West Eighth Street, recently incorporated with a capital of \$35,000, is rushing to completion work on its new plant, and will inaugurate operations before the close of the month. The company will manufacture babbert metal, ingot copper, brass, pig lead and spelter.

SALT LAKE CITY.—The Utah Oil Refining Company is having plans prepared for the erection of two additions to its plant, to comprise a wax filtering works and a boiler plant, to cost \$50,000.

Virginia

IVANHOE.—The National Carbide Company, recently incorporated with a capital of \$350,000, has acquired twenty-two acres of land near Ivanhoe as a site for a new plant to be devoted to the manufacture of carbide. Contracts for the new works have been awarded.

Washington

CENTRALIA.—The Pacific Reduction & Chemical Company, recently incorporated with a capital of \$500,000, has had plans prepared for the erection of a new coal briquetting plant near Tenino, to cost about \$80,000. H. P. Scheel and William McArthur, both of Tenino, and F. M. Lane, of Tacoma, head the company.

West Virginia

FAIRMONT.—The Mononga Glass Company, manufacturer of glassware of all kinds, has awarded a contract for the construction of a new four-story addition to its plant, about 160 x 370 feet, to cost approximately \$250,000.

HUNTINGTON.—The Lamie Chemical Company, recently incorporated with a capital of \$50,000 to manufacture chemicals, has acquired the old plant of the Blue Jay Overall Company. The company has commenced the installation of equipment, and is planning to inaugurate operations in the very near future.

Wisconsin

MILWAUKEE.—The Standard Steel Company has acquired a site of twenty-three acres for the erection of a new plant for the manufacture of agricultural implements, etc. The company has filed notice of an increase in its capitalization from \$50,000 to \$300,000 for expansion.

MILWAUKEE.—The Milwaukee Forge & Machine Company is making rapid progress in the construction of its new plant in Lake, which is being erected at a cost of \$100,000. The works will comprise a machine shop, 65 x 100 feet, and a forge building, 75 x 140 feet.

Financial

COLORADO FUEL & IRON CO.—The annual meeting of the stockholders and directors of the Colorado Fuel & Iron Company, held in Denver recently, was devoted to consideration of the most prosperous era in the history of the corporation as shown in the report of President J. F. Welborn and the election of directors and officers.

There was but one change in the entire list, that being the advancement of J. B. McKennan to vice-president. He was formerly general manager and will now hold both offices.

John D. Rockefeller, Jr., heads the board of directors. There are five other New York directors, including John H. McClelland, Starr J. Murphy, Willard P. Ward, Bertram Cutler and David H. Taylor.

The directors elected from Denver include J. F. Welborn, Joseph Chilberg, Cass E. Herrington, J. B. McKennan, S. G. Pierson, Albert A. Reed and J. A. Writer.

The following officers were elected: J. F. Welborn, president; Starr J. Murphy, vice-president; J. Chilberg, vice-president and manager of sales; S. G. Pierson, vice-president and general purchasing agent; J. A. Writer, secretary and treasurer, and J. B. McKennan, vice-president and general manager.

The following compose the executive committee: J. F. Welborn, Joseph Chilberg, Albert A. Reed, S. G. Pierson and Cass E. Herrington.

The holdover appointive officials are E. S. Cowdrick, assistant to the president; L. B. Rogers and E. V. Cary, assistant secretaries; A. D. Moss, assistant treasurer; Cass E. Herrington, general counsel; Fred Herrington, general attorney; R. H. Hart, attorney; R. L. Hearon, traffic manager; F. H. Bentley, auditor; E. H. Weltzel, manager fuel department; F. E. Parks, manager Minnesota works.

Within the last year the company has caught up on its dividends on the preferred stock and is now paying a dividend on the common stock. The gross receipts from sales for the year ending June 30, 1917, were \$40,004,886.78 compared with \$25,626,605.54 in the previous year, an increase of 56.1 per cent.

Operating expenses were \$31,771,568.23 compared with \$21,280,519.74, and net earnings from operation were \$8,233,318.55, an increase of \$3,887,232.75 or 59.5 per cent.

Income from sources other than operation was \$786,283.89, making a total net income of \$9,019,602.44, compared with \$4,971,076.68 in the previous year.

Mention is made of three increases in wages made during the year. The report concludes:

"During the six months the retirement plan has been in effect, thirty-eight employees have been retired on a total monthly allowance of \$849.60.

"Our employees show evidence of satisfaction with working and living conditions and wits wages."

GREAT WESTERN ELECTROCHEMICAL.—A special meeting of the stockholders of the Great Western Electrochemical Company has been called for Nov. 28 for the purpose of acting on a proposition to increase the capital stock. It is proposed to increase the company's capitalization from \$2,500,000 to \$5,000,000 by increasing the common stock from \$1,500,000, par value, to \$2,500,000 and by increasing the preferred from \$1,000,000 to \$2,500,000.

President Mortimer Fleishacker, in his letter to stockholders notifying them of the call for the meeting, says:

"During February last you were notified of an enlargement of our plant at Pittsburg, Cal., and were offered the remaining preferred stock then in the treasury, with certain common stock. This stock was all subscribed and has been issued and the work of this addition practically completed. Since that time it has been deemed wise to build a plant for the hardening of oils, thus utilizing the hydrogen gas produced in our process which heretofore has gone to waste. The company has also found it necessary to increase the capacity of the potassium chlorate plant 100 per cent. In order to take advantage of the large and favorable market for both of these products. These increases in production make it necessary to secure additional working capital.

"That no delay may occur, and in order to provide funds for the additions to the plant and working capital mentioned above, the board of directors has decided to offer to present stockholders (in proportion to their holdings of preferred and common stock), \$375,000, par value, of the new preferred stock, and \$250,000, par value, of the new common, at the price of \$100 a share for the preferred.

LENZ APPARATUS CO.—The capital stock of this company has been increased

to \$50,000, of which increased capital stock \$35,000 have been subscribed and actually paid for in cash, thus giving the company ample working capital to conduct its business profitably, according to the treasurer of the company.

Manufacturers' Notes

NEW SEATTLE ASSAY STORE.—The Assay Supply Dept. of the Stewart and Holmes Drug Co., has opened a new store and headquarters at Third Avenue South and Main Street, Seattle, Wash.

THE WELLMAN-SEAEVER-MORGAN COMPANY of Cleveland, Ohio, has established a Seattle office in charge of Mr. Glenville A. Collins. The office is located in the L. C. Smith Building.

THE ELECTRIC FURNACE CONSTRUCTION CO., Finance Building, Philadelphia, announces the following installations of "Greaves-Etchells" electric furnaces: American Radiator Co., Buffalo, N. Y., second order for a six-ton furnace; Stoddard Union Co., Lockport, N. Y., one ton furnace; Primos Chemical Co., Primos, Pa., one special furnace for ferro alloys; T. Waddell & Sons, New Zealand, one two-ton furnace.

SITES FOR CHEMICAL PLANTS.—The great industrial growth about the metropolitan area of New York has brought many new concerns to this section; particularly where acreage is required there has been a great influx to the property bordering the Passaic and Hackensack rivers where the advantage of both railroad sidings and water facilities are good, a great many large chemical concerns locating there recently.

A new section of property aggregating several hundred acres has just been opened up at Fairview adjoining the large soap works of B. T. Babbitt & Company with a frontage of about 10,000 ft. on the Hackensack River bordered by the West Shore and Erie and Susquehanna railroads. Messrs. Wm. D. Bloodgood & Co., Inc., Long Island City, N. Y., have been appointed the selling agents for this property.

New Publications

COKING OF ILLINOIS COAL. By F. K. Ovitz. Bulletin No. 138, published by the Bureau of Mines, Department of the Interior.

ABSORPTION OF METHANE AND OTHER GASES BY COAL. By S. H. Katz. Technical Paper 147, published by the Bureau of Mines, Department of the Interior.

PREPAREDNESS CENSUS OF MINING ENGINEERS, METALLURGISTS AND CHEMISTS. By Albert H. Fay. Technical paper 179, published by the Bureau of Mines, Department of the Interior.

SOME UNIQUE FEATURES OF ELECTRIC ELEVATOR CONTROL. A reprint of a convention address by Harrison P. Reed, engineer with the Cutler-Hammer Mfg. Co., delivered at the Fourth Annual Convention of the Elevator Manufacturers Association of the United States, Oct. 10-12, 1917, Milwaukee, Wis.

POTASH IN 1916. By Hoyt S. Gale. Pages 73 to 171 of Mineral Resources of the United States, 1916—II, published Sept. 10, 1917, at the Government Printing Office at Washington, D. C.

THORIUM MINERALS IN 1916. By Waldemar T. Schaller, pages 223 to 237 of Mineral Resources of the United States, 1916—II, published Sept. 13, 1917, at the Government Printing Office at Washington, D. C.

REFLECTING POWER OF TUNGSTEN AND STELLITE. By W. W. Coblenz and W. B. Emerson. Scientific Paper of the Bureau of Standards, No. 308, issued Aug. 10, 1917.

Manufacturers' Catalogs

THE PREST-O-LITE COMPANY, INC., Indianapolis, Ind., has issued a booklet on "Turning Waste into Profit," devoted to the possibilities of reclaiming broken and worn machinery and metal parts for service by the oxy-acetylene process.

THE DENVER FIRE CLAY CO., Denver, Col., has issued a pamphlet on Caselle Cupels, Bulletin 200 on case crushers and pulverizers, samplers, sieves, mortars, etc., and Bulletin No. 100 on metallurgical clay goods, muffles, crucibles and scoriae.

THE GEORGE J. HAGAN COMPANY, Pittsburgh, Pa., has issued a bulletin entitled "Twelve Reasons Why Your Choice Should Be the 'Hagan,'" describing the ash conveyor.